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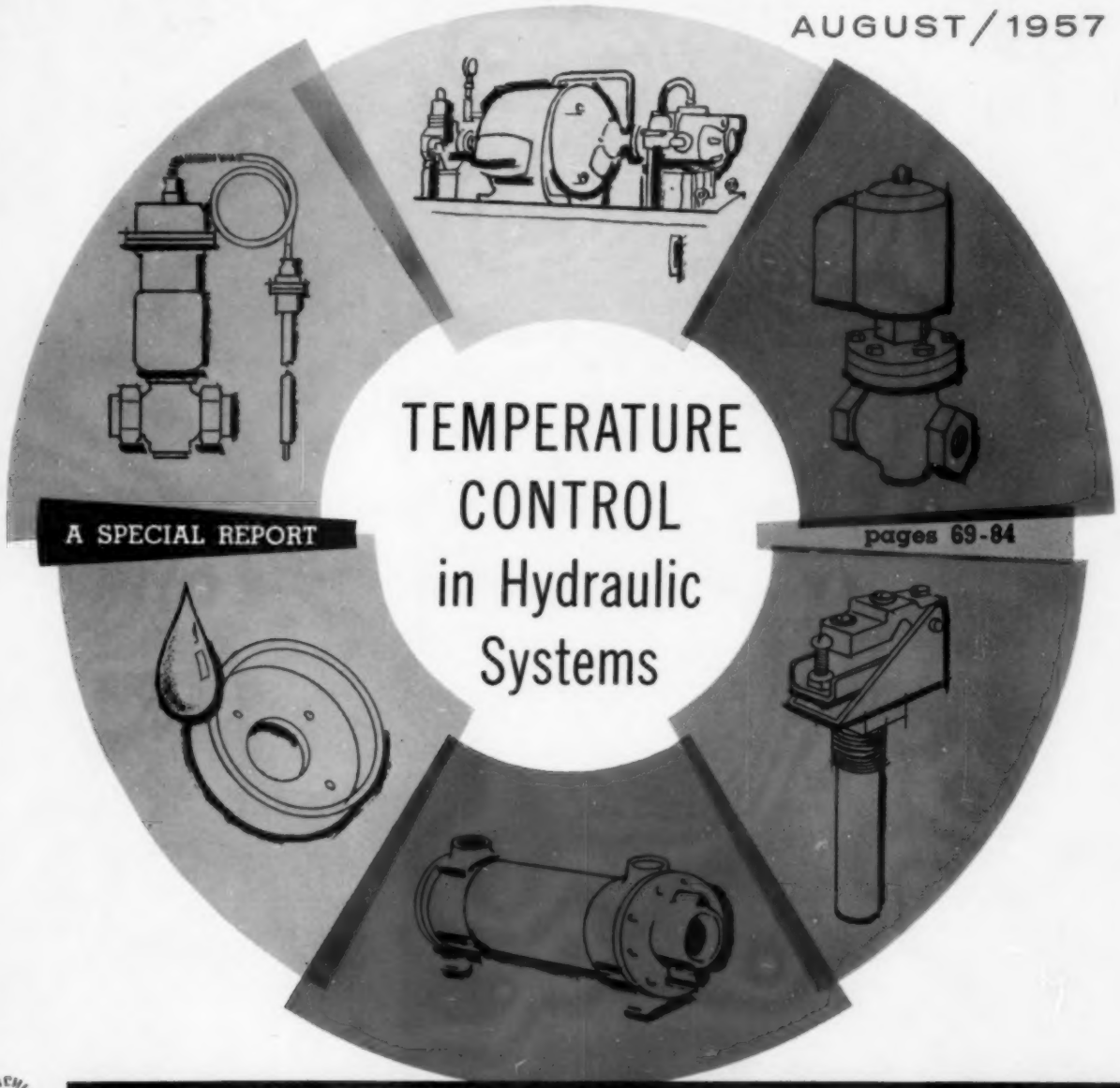
Applied Hydraulics

PNEUMATICS · ELECTRICAL CONTROLS

AUGUST/1957



A SPECIAL REPORT

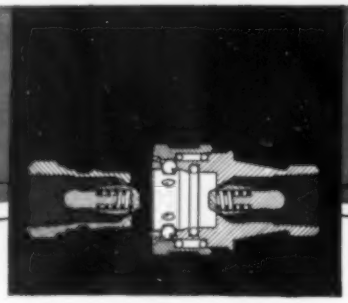
TEMPERATURE CONTROL in Hydraulic Systems

pages 69-84

THE MAGAZINE OF FLUID POWER

AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

Now in Preparation
1958/59 FLUID POWER DIRECTORY
For complete details, see pages 30-31



shuts off both sides of line... prevents loss of liquid, gas, or pressure.

Wherever 2-way shut-off is required...

HANSEN

QUICK-CONNECTIVE TWO-WAY SHUT-OFF COUPLINGS

FOR PRESSURE OR VACUUM SERVICE

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line—practically eliminate spilling of liquid or escape of gas at instant of disconnection.

Hansen Series HK Two-Way Shut-Off Couplings are available with female pipe thread connections from ⅛" to 1" inclusive. Available in brass or steel. Sizes generally required for L-P Gas service have approval of Underwriters' Laboratories.

WRITE FOR THE HANSEN CATALOG

Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes of Hansen One-Way Shut-Off, Two-Way Shut-Off, and Straight-Through Couplings—including Special Service Couplings for Steam, Oxygen, Acetylene, etc.

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with Micrometer Accuracy

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For AIR, OIL and WATER operation to 250 p. s. i.
SIZES ¼" • ⅜" • ½" • ¾"
TEMPERATURES to 250°F

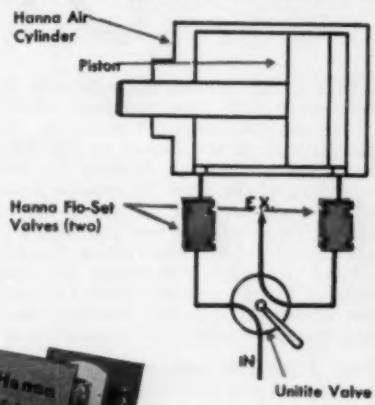
Hanna Flo-Set Valves are used to control cylinder piston speeds and operating speeds of many types of fluid actuated mechanisms. They are able to handle air, oil, water and many gases. When used with cylinders, these valves permit independent adjustments of forward and return piston speeds. The diagram at the right shows a typical circuit. Flo-Set Valves make the operation of air cylinders smoother and make cushioned cylinders more effective by building up essential back pressure.

Fluids pass unobstructed in the direction of the arrow on Hanna Flo-Set Valves. In the opposite direction, flow can be controlled from zero to full pipe capacity. One valve can be set to an infinite number of controlled flow positions. Once set, the position can be held by means of a locking collar. Established flow positions can be reset by using the micrometer graduations which accurately measure flow as a percent of full pipe capacity.

One revolution of the aluminum valve body will change the flow rate from zero to full capacity. No tools are necessary! In addition to the standard ¼", ⅜", ½" and ¾" sizes, there is a ¼" Jr. model, without micrometer graduations or locking collar, for light piping and tubing.

Typical Cylinder Circuit Using Hanna Flo-Set Speed Control Valves

Hanna engineers will gladly recommend circuits to help you with your applications.



Consult your classified telephone directory or Thomas' Register for your nearest Hanna representative. Write for Hanna Valve Catalog 254 and Flo-Set Valve Bulletin 253A.

Hanna Engineering Works

HYDRAULIC AND PNEUMATIC EQUIPMENT . . . CYLINDERS . . . VALVES . . . RIVETERS

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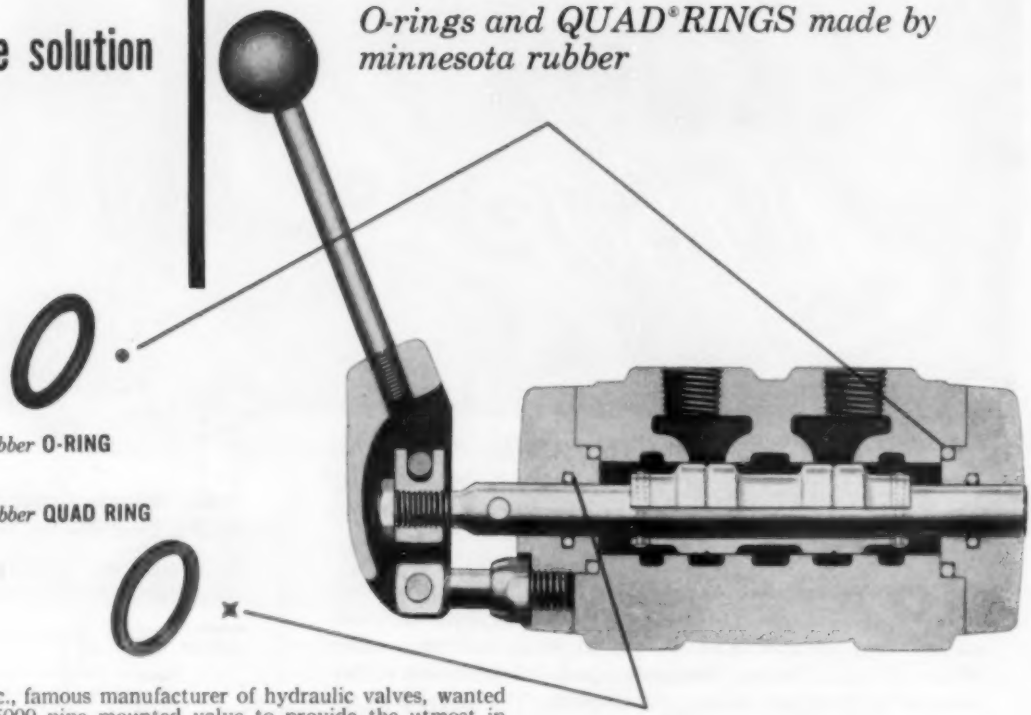
hydraulics problem

how to eliminate gaskets and reduce friction to improve design of a pipe mounted valve

simple solution

O-rings and QUAD® RINGS made by minnesota rubber



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minnesota rubber **QUAD RING**

RIVETT, Inc., famous manufacturer of hydraulic valves, wanted their Series 5000 pipe mounted valve to provide the utmost in simple, smooth, leakproof operation. A special *floating piston* was incorporated in the design of the valve. This exclusive feature eliminated sticking or binding by keeping the valve stem independent of the bore. To provide a stem seal that would greatly reduce friction, RIVETT chose the Minnesota Rubber QUAD RING. This exclusive seal provided a perfect seal with much less squeeze making operation easier. To obtain design simplicity, more efficient operation and longer life, gaskets were eliminated and replaced by Minnesota Rubber O-Ring cover seals. This combination of advanced design elements and Minnesota Rubber Seals permits multi-million cycle operation at 1500 PSI.

What Minnesota Rubber Seals offer you. An exclusive injection molding process means that Minnesota Rubber QUAD RINGS, O-Rings and other rubber parts are denser and tougher. Their tremendous uniformity and strength mean greater dependability, longer life. Quad Rings give you 4-lip sealing action, seal at less than 1 PSI, require only 60-100 micro-inch groove finish and eliminate "spiral twist." Minnesota Rubber O-Rings are available to you with tolerances as close as ± .002", cost as little as ordinary O-Rings and are produced with no flash or other imperfections that require trimming. An enormous selection of standard sizes assure immediate delivery.

Note: QUAD RING is a Trade Mark of the Minnesota Rubber & Gasket Co.

Free samples and data. A sample of Minnesota Rubber seals is available together with complete technical data. Simply write . . .

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Originators of modern rubber injection molding.

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Applied Hydraulics

Volume 10/Number 8

AUGUST 1957

THE MAGAZINE OF FLUID POWER

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ENVIRONMENTAL HYDRAULIC PNEUMATIC TEST EQUIPMENT

SPECIAL HYDRAULIC POWER UNIT FOR RAISING "NIKE" LAUNCHER. OPERATES AT 3000 PSI.

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Applied Hydraulics

THE MAGAZINE OF FLUID POWER

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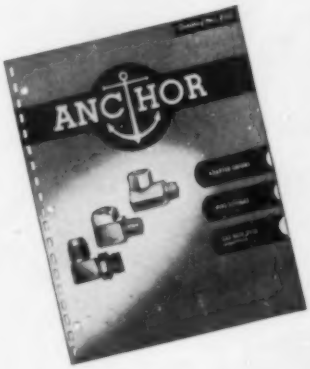
Useful Literature

EXPANDED LINE OF HYDRAULIC FITTINGS, UNIONS AND ADAPTERS IN NEW ANCHOR CATALOG!



The new edition of Anchor's Catalog covering the complete and enlarged line of unions, fittings and adapters is just off the press and now available on request.

The Catalog contains a great deal of engineering data that will prove helpful to the engineer in planning his hydraulic connections.

The Anchor Line of Adapter Unions, Tees and Crosses is now even more complete in range of sizes and styles of fittings. Designed for use with Pressed On and Reusable Coupling Hose Assemblies, they provide a ground joint, leakproof connection, and eliminate one or more pipe thread joints. Assembly, especially in confined quarters, is made easier and twisting and straining of the hose during assembly is prevented.

The Anchor Line of SAE Straight Thread "O" Ring Boss Fittings and Adapters is described in detail with complete specifications. These recently introduced fittings, with their straight thread and "O" Ring Seal, ensure positive leakproof seating without danger of thread distortion or damage. Connections can be loosened and retightened any number of times without leaks. Straight, 45° and 90° Adjustable Elbows are available with a tee, service tee and 90° check valve, in a wide range of sizes.

Several styles of Anchor Tube Nuts for tube diameters from ⅛" to 2" are shown.

Copies of the new Catalog No. 203 may be obtained by writing to Anchor Coupling Co. Inc., 341 North Fourth Street, Libertyville, Illinois.

SAVE Time, Expense and Effort

with

ANCHOR FLANCO

4-Bolt, Split-Flange, "O" Ring

CLAMP

—with the **TILT-PROOF** *and* **BLOW-OFF PROOF DESIGN**

Flanco Split-Flange Couplings provide an easily-made, leak-proof "O" Ring Head connection. There are no threads to wear out, or tapered seats to groove—no wedging of pump or valve bodies by tapered pipe threads! The use of gaskets and sealing compound is eliminated—there is no spiral leakage. The higher the pressure, the tighter the "O" Ring seals!

Anchor Split-Flange Clamp design gives you a tilt and blow-off proof clamp. By locating the plane of the split-flange clamp half bolt centerlines so that it passes through the center of force of the flanged head on the split-flange clamp half, unbalanced moments are eliminated. This patented design principle prevents tilting of the clamp half and extrusion of the "O" Ring.

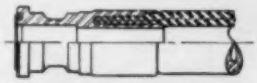
Anchor Flanco Split-Flange Couplings can be used to connect hose assemblies to valve or pump bodies, or, in pairs with connector plates, to connect hose to hose, or hose to pipe. They are available in sizes from ½" to 3" I.D. hose and in low or high pressure styles to provide a dependable, trouble-free connection.

A new Anchor Swivel Joint, with full 360° swivel, provides maximum convenience and flexibility in installation and avoids twisting and distortion of hose. They are available in all standard angles for high pressure 2-wire braid pressed-on hose assemblies from ½" to 2" I.D.

Andy Anchor Says:

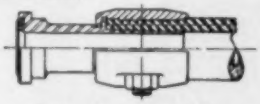
For the complete story of the many advantages offered by Flanco Split-Flange, 4-Bolt, "O" Ring Head Couplings and their time and money saving features, write for Catalog No. 401!

Available 4 Ways



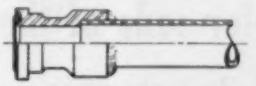
Pressed-On Couplings

Streamlined Couplings, factory applied to make dependable hose assemblies, utilizing the same time-proven hose swaging methods which have made Anchor the leader in the industry.



Clamp-Type Couplings

Ideal for making emergency repairs in shop or in the field with a minimum of down time. Also exceptionally well-suited for the plumbing of special or experimental units.



Weld-Type Couplings

Used to connect pipe or tubing to hydraulic hose, or for coupling pipe to system components, or pipe to pipe with quick, sure, leak-proof connections.

Stem-Angles

Available in Pressed-On or Clamp-Type Couplings, these stem-angles come in 22½°, 30°, 45°, 60°, 67½° and 90° basic angles. With the Flanco Swivel Split-Flange's 360° swiveling feature, universal positioning is provided.

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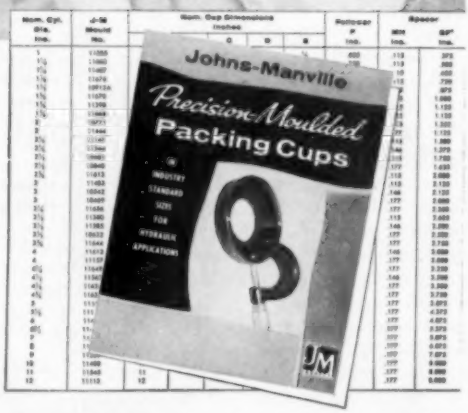

Ask for new size list and compound color code of these J-M Packing Cups

Made in the original *square heel* design, developed and perfected by Johns-Manville, these cups are precision made to assure maximum efficiency.

They are available in a variety of styles and compounds to suit most pressures, temperatures and fluids. For easy identification, cups are marked with a different color stripe for each compound.

Complete dimensions, compounds, code and piston design data are in folder PK-107A. Write Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ont.

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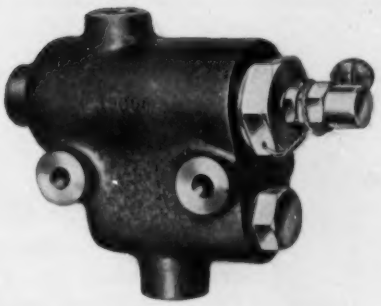
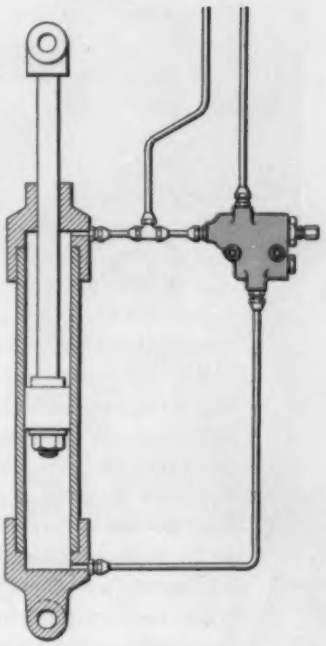
The LOCKHEED *'Hydroloc'* VALVE

locks a hydraulic slave unit securely in any position without line pressure





This simple and effective unit creates a hydraulic lock in one end of the slave cylinder until the other end is fed under pressure, when the 'lock' is automatically released. Even if the slave cylinder is released under a heavy reactive load, the 'Hydroloc' prevents judder.

The 'Hydroloc' is simple, very easy to install, and needs no mechanical connections. If the load is always 'one-way' such as in a slave cylinder with a spring-loaded return, one single-type 'Hydroloc' is sufficient. If the load changes direction, the twin 'Hydroloc' valves, or two single valves, hold the piston in both directions.

'Hydrolocs' are available immediately in $\frac{1}{4}$" B.S.P. and for pressures up to 2000 p.s.i.

For further details of this and other Lockheed industrial units, please write for pamphlets and kindly mention this journal.

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Fluid Power Lines

about Applied Hydraulics

BEAT THE HEAT . . . Everyone's favorite greeting these days is, "Is it hot enough for you?" While they are, of course talking about the weather, AH editors thought this would be an excellent time to talk about another hot subject—*temperature control in hydraulic systems.* Why do machines run hot? What can you do about it during the design stage or after the machine is installed? What happens when machines overheat? These are the kind of questions we put to designers who are particularly concerned about temperature.

We sat down with engineers who have years of experience in designing for efficiency. We discussed the problem with manufacturers of fluids and packings to find out what happens to these at the higher temperatures. And, of course, we got information from the temperature control people themselves: manufacturers of oil coolers, water controls, and immersion heaters.

This information is presented in a 16-page report, complete in this issue. While you may not be able to use all of the ideas here, we hope they generate some of your own ideas on keeping cool.

Reprints of this 16-page report on Temperature Control are available. Single copy price is 25 cents.

ACTION-REACTION . . . In aircraft hydraulic control systems, high performance can be affected by the static reaction or steady-state axial forces on valve spools. Much original development work to reduce these forces has been done in this country and abroad. Four designs are outlined in the article, *Reducing Static Reaction.* These are evaluated and compared with special emphasis on manufacturing problems.

JOLLY GOOD FELLOW . . . We're very proud that our European Editor, John Lankester, has been elected an Associate of the Royal Aeronautical Society in England. Founded in 1866, the Society has for its purpose the general advancement of the aeronautical art, science and engineering.

NEUE PRODUKTE . . . Say the word "Detroit" to an industrialist anywhere in the world and he will immediately think of mass production, transfer machines, and automobiles at 1000 an hour. To show that foreign engineers are coming up with clever, practical ideas, the hydrostatic transmission article on page 123 outlines German and Italian inventions for an industrial truck and motorcycle. Both designs use axial piston pumps and motors. Think it would work on a lawnmower?

FALL SPENDING SPREE . . . Judging of entries in the 1957 APPLIED HYDRAULICS Prize Paper Contest is being completed. Winners will be announced in the October issue. Seven checks totalling $1200 will be presented to prize winners. The three top awards will be handed to the winners at a session of the National Conference on Industrial Hydraulics in Chicago's Hotel Sherman, October, 17th.

In this Prize Paper Contest almost everyone wins. Ninety percent of the entries merit publication. During coming months these papers will appear in AH. Those which aren't awarded cash prizes will be paid for at our regular rates.

Watch for announcement of the 1958 Prize Paper Contest.

PRECISION "O" RINGS

Quality proved by all ASTM Tests

Precision "O" Rings made from Compound 830-70 meet or exceed all the SAE 120-R requirements for heat, oil resistance and other properties.

100% better compression set. Remarkable superiority in 300° F hot oil. 100% better Fatigue Test life.

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NEW!
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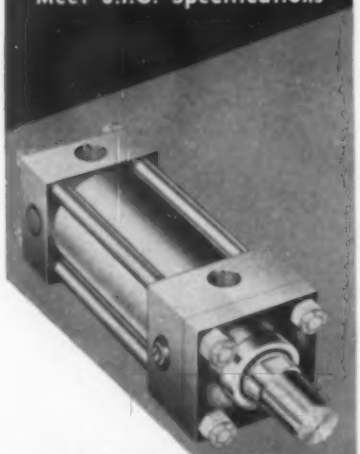
Heavy Duty Air & Hydraulic CYLINDERS
Meet J.I.C. Specifications



Square head, tie-rod design is used on this compact, space saving line of cylinders which have machine tool quality.

AIR CYLINDERS
Precision designed for heavy duty service ● 1-½ to 14-in. bore ● all steel with honed brass cylinder barrel ● single or double rod ends ● 13 different mountings ● interchangeable mountings and rod end styles with any other leading cylinder manufacturer ● cartridge type piston rod bronze bearing ● adjustable cushions ● aluminum alloy one piece piston ● self regulating, wear compensating seals.

HYDRAULIC CYLINDERS
All steel ● 2000 to 3000 psi service ● 1-½ to 12-in. bore ● single or double rod ends ● 15 different mountings ● cylinder barrels honed to 10 micro-inch finish ● one piece precision alloy iron piston ● alloy step-cut piston rings ● cartridge type piston rod bearing ● adjustable cushions ● interchangeable mountings and rod end styles with any other leading cylinder manufacturer.

We also build special cylinders. Select territories still available to qualified representatives.

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Fluid Power Lines

continued

MEET BILL MATTHEWS . . . He's the author of the article starting on page 90. Living in Spokane, he's watched the great Northwest grow industrially and has been active in the application of hydraulic circuits. We first met Bill in 1951 while taking a summer course in hydraulics at M.I.T. To Bill this course was a home-coming because he graduated from M.I.T. in 1921 and received his Master's in 1922. Bill's an engineer who likes to write, particularly about hydraulics. You'll be seeing more of his articles in AH.

HYDRAULICS TRAINING . . . This month is planning time for the schools throughout the country. That's why we're publishing Bob Reeve's article on pages 100 and 101. If you're planning a course in hydraulics, you'll get some ideas from this article. While Bob is also an instructor, his main concern is to organize courses for industry.

ROTARY ACTUATOR . . . New designs of rotary actuators —limited rotation fluid motors—are appearing on the market at an increasing rate. We've recently been shown one which incorporates a position servo system, and an article received in the AH Prize Paper Contest describes a similar unit designed in France. The special machine outlined on page 94 illustrates an excellent application of an air-operated actuator.

NEXT MONTH . . . Keith Carlson, AH's associate editor has prepared a study of rotary air motors. It's a detailed report on design, selection and application.

An unusual circuit developed by Simplex Engineering's Bob Raymond will show how accumulators can be used to synchronize cylinders.

Three articles on air circuitry, three on product development and four on applications will give you a well balanced coverage of fluid power . . . and . . .

. . . ***A NEW ENLARGED AVIATION SECTION*** . . . Although designers of fluid power for industrial use can always swap ideas with aviation engineers, they do have distinct areas of interest. Recognizing this, AH started an aviation section in 1950. Reader interest has been great and inevitable growth has led to enlarging the section which will be introduced next month.

WEBSTER'S NEW PILOT OPERATED RELIEF VALVE

Compact design adapts to "tight" installations. Adjustable from 500 to 2000 psi. Maximum capacity, 20 gpm.

BOOSTS WORK OUTPUT 38.5%!

call the man from Webster

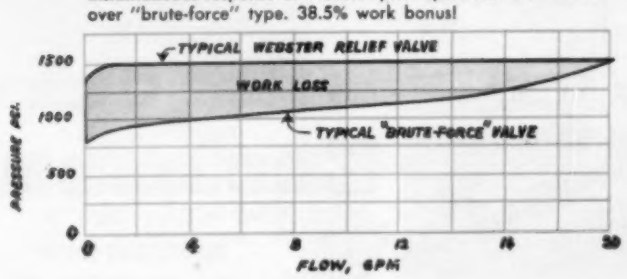
His intimate knowledge of this new relief valve — its many benefits and applications — can help in adapting it to your product.

Full speed power up to 93% of relief setting is now possible with this new Webster pilot operated relief valve. Result: 38.5% work bonus over "brute-force" type valves! More, you get all the benefits of clog-free performance, quieter operation...lower price. Mighty sound reasons for specifying Webster's pilot operated relief valve *now*.

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC
MELROSE 3-3611
RACINE · WIS

Typical performance curve shows minimum pressure drop and instantaneous response of Webster pilot operated relief valve over "brute-force" type. 38.5% work bonus!



- ☐ *Have THE MAN FROM WEBSTER contact us—*
  —Please send the following:
- ☐ *Bulletin H3A2 covering the new Webster pilot operated relief valve*
- ☐ *Complete hydraulic catalog of pumps, valves and fluid motors*
- ☐ *New information or data as published*

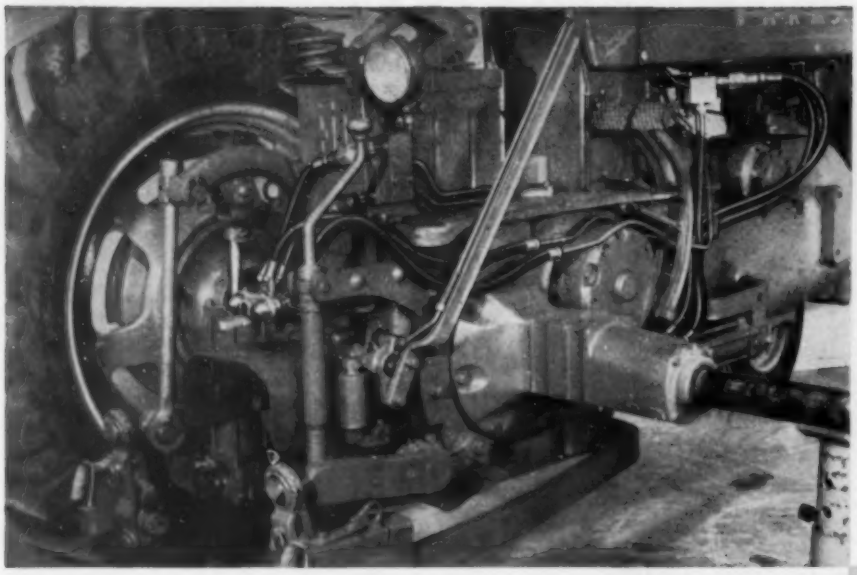
Name_____

Title_____

Company_____

City_____ State_____

franklin adv. H104



INTERNATIONAL HARVESTER'S
McCORMICK FARMALL 400
Tractor controls every implement action hydraulically through its famous Hydra-Touch hydraulic system. Individual, closely grouped levers permit independent or unison control of cylinders.

HYDRAULIC POWER . . . DELIVERED THROUGH

Eastman

HYDRAULIC HOSE ASSEMBLIES . . .

Most competitive Farm Implement Sales Feature

HYDRAULIC POWER probably contributed more to the usefulness, efficiency, and easy operation of farm tractors than any other modern engineering development. Farmers appreciate hydraulic advantages so much that they have become one of the *most competitive features in implement and tractor sales promotion.*

EASTMAN MANUFACTURING COMPANY is proud to have among its many agricultural users the International Harvester Company—dating back to the first McCormick Reaper—in 1831. Eastman—*first in the field* of Hydraulic Hose Assemblies—lists many other agricultural implement manufacturers among its users: J. I. Case, Allis-Chalmers, Massey-Harris-Ferguson, Inc., Minneapolis-Moline, Farmhand, Avco, and others.

IMPROVE THE COMPETITIVE POSITION OF YOUR PRODUCTS with Hydraulic Power—delivered through Eastman Hydraulic Hose Assemblies. Always specify Eastman: First in exclusive engineering advantages and design! First in materials and workmanship! *First in the field* of Hydraulic Hose Assemblies!

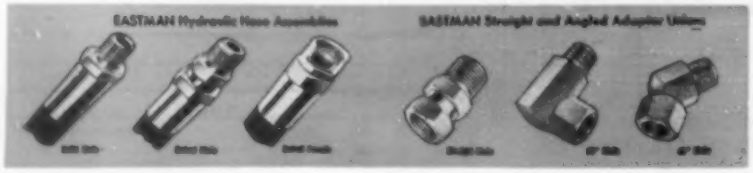
WRITE Send your specifications and blueprints for our original equipment quotations.

HYDRAULIC POWER controls plow penetration and depth automatically, lifting and locking in traveling position.

HYDRAULIC POWER controls angle and depth of disc penetration on International Four-Hitch Deck and Rog Harrow.

HYDRAULIC POWER enables Farmall 200 Hydra-Creeper to travel 1/5 to 1 mile per hour for transplanting.

HYDRAULIC POWER permits raising right, left, or rear cultivator gangs separately, together, or any combination.



Eastman
first in the field
MANUFACTURING COMPANY
Dept. AH-8, Manitowoc, Wis.

LETTERS
to the editor

Address your letters to: Editor, APPLIED HYDRAULICS Magazine, 812 Huron Rd., Cleveland 15, Ohio.

Elevator Problems

We have a problem in hydraulic elevator cylinders, and wonder if you have had experience with the use of telescopic pistons for hydraulic elevators. The problem appears to be: with the increased speeds we are getting into, the change of speed. due to the change of diameters of piston, becomes very noticeable. There is also quite a noticeable noise when one piston stops to pick up the other. Same is apparent on the downward travel. Any help you can give us would be appreciated.

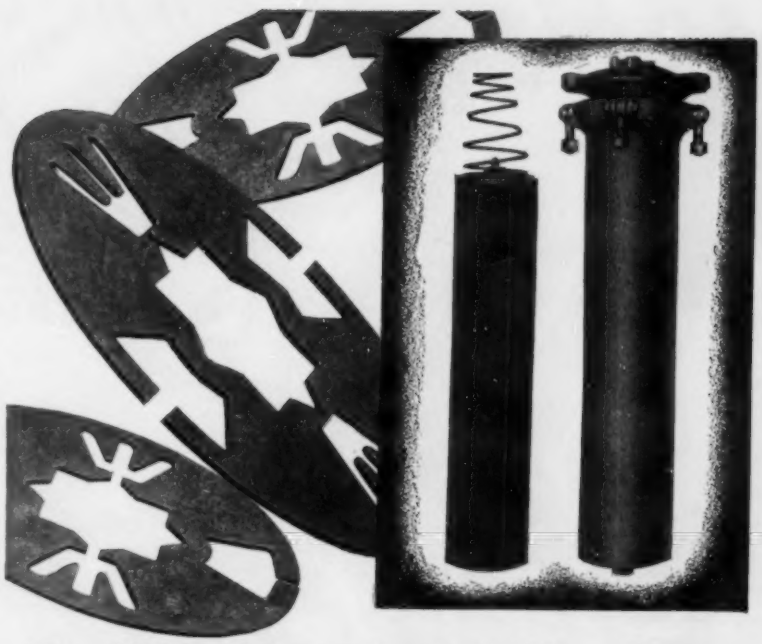
E. M. SHAW
Manager
Canada Crane & Hoist Co.,
525 Richmond St., West
Toronto 9, Ontario

Changing speeds caused by the use of telescoping pistons can be corrected by proper circuit design. We have not encountered an application where this has been a particular problem. The noise you mention as one piston stops to pick up another is probably due to pressure increase in the system. Noise on hydraulic elevators is a problem that can best be minimized by proper application and selection of the pump. Sorry that we cannot be more specific—it requires actually sitting down and working through the circuit. We have sent the name of a Toronto organization that should be able to help you solve your problem.

Heat Exchangers

Please send me a list of manufacturers of high-pressure, high and low-flow-rate heat exchangers. I am interested in a temperature range from —100 to 600 F, with flows to 300 gpm, and pressures

Continued on page 16



the NUGENT Laminated Disc Filter

This "extended area" filter utilizes an actual filtering surface area greatly in excess of its container area. The Nugent Laminated Disc Filter provides a high flow rate at low pressure drop combined with the extreme fine filtering absorption and neutralizing properties of a depth type filter.

The filter charge consists of a stack of similar crenulated fiber discs, each rotated 45° from the position of the adjacent disc, thus affording proper channeling and maximum filtering capacity. Liquid passes from the exterior to the interior of the filter stack.

The filter recharge has a useful life of from 4 to 10 times that of a cellulose or waste recharge. Changing recharges requires only minutes. Cartridges are interchangeable with all other Nugent bag or depth type cartridges. Write for full details.

DESIGN FEATURES

- Provides "Extended Area" filtering
- Removes solids as small as 2 microns
- Removes acid forming contaminants
- Will not remove additives
- Contains no chemicals or bleaches
- Working pressure 125 psi—tested to 375 psi
- High pressure filters to 600 psi—tested to 3000 psi
- Built in by-pass relief
- Maximum operating temperature 375°F.

HOW IT WORKS

Each disc in filter stack is rotated 45° from position of adjacent disc for proper channeling and maximum filtering capacity.

Established 1897

Wm. W. Nugent & Co., Inc.
3432 Cleveland Street Skokie, Illinois

OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

Representatives in Boston • Cincinnati • Detroit • Houston • Los Angeles • New Orleans • New York • Philadelphia • Pittsburgh • San Francisco • Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver • Winnipeg

New U.S. MOTOMOUNT SYNCROGEAR

Designed to meet J.I.C. Specifications

In one compact power package a high-speed NEMA foot-mounted motor and a low-speed, double reduction gear transmission. Motor change in minutes! And with U. S. Motomount Syncrogear, the change is not limited to the type motor being replaced! If *you* carry a spare motor inventory, here is real flexibility and quick-change. U. S. Uniclosed, Totally-Enclosed, or Explosion-Proof motors of the same NEMA dimensions and ratings may be used to meet changing requirements. Available in h.p. ratings 1 to 30. U. S. Motomount Syncrogear has solid shank ever-tight pinion, friction-free oil seal, thru-hardened gears—many advanced features for longest life.

MOUNTS LIKE AN INTEGRAL UNIT, FOR INHERENT ALIGNMENT... Both units of the U. S. Motomount Syncrogear have rugged, pyramidal base construction—made-to-match pyramids to hold motor and mount aligned for life—factory alignment PLUS centralized responsibility for manufacture of both components.

CAST IRON FOR ALL EXTERNAL PARTS . . . For tough, industrial duty! Besides providing structural stability, cast iron protects against corrosive elements. All castings normalized for permanent retention of precision machining.

TAKES THE NEW RE-RATED NEMA MOTORS...U. S. Motomount Syncrogear takes the re-rated NEMA motors in the new sizes. The wide range thus acceptable enables you to reduce spare motor inventory!

U. S. ELECTRICAL MOTORS, Inc. AH-8
P. O. Box 2038, Los Angeles 54, Calif., or Milford, Conn.

☐ *Request Full Information about Motomount Syncrogear*

NAME_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

U.S. Electrical MOTORS

MAIL COUPON NOW

ACCO
Helicoid
Gage
U.S.A.

NOTHING BUT THE BEST IN GAGES FOR WORKING PRESSURES FROM 30" VACUUM TO 10,000 p. s. i.

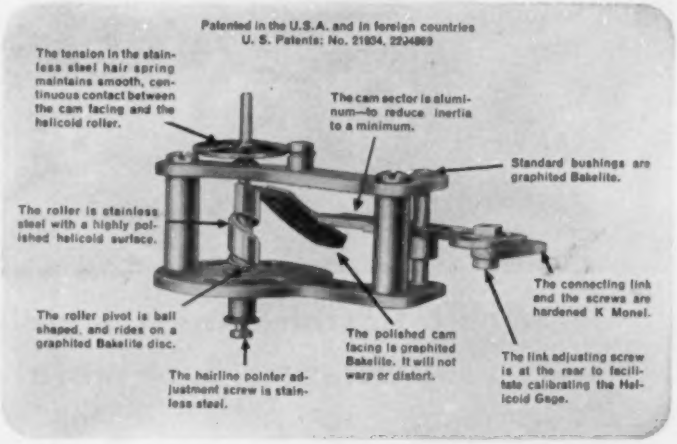
Shock-Proof Cam Actuation (no gears—no teeth) Makes Helicoid Gages Ideal for Hydraulic Services

Designed for pulsating and impact hydraulic service, the Helicoid movement releases at zero in the event of sudden pressure reduction. This eliminates shock on pointer and movement by reducing impact of pointer against pointer stop pin. This protects the gage mechanism where gages may be subject to occasional vacuum.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or certain severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown at the right.

Rolling action of the cam facing against the roller surface . . . graphited Bakelite bushings, roller pivot base and cam facing . . . K Monel connecting links and screws . . . all such Helicoid features protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation through millions of cycles.


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21834, 224869
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

HELICOID GAGE CARTRIDGE SNUBBER

(Patent pending)

This is a simple, effective throttling device to reduce or eliminate pulsations of the gage pointer. There are no moving parts, no adjustments needed. Available in three types in powdered bronze or stainless steel for air, gas, water, steam, medium or heavy liquids.

Enlarged cutaway view

Threaded cartridge body for assembly in any Helicoid Gage tapped socket shank

EASIEST ADJUSTMENT AND CALIBRATION

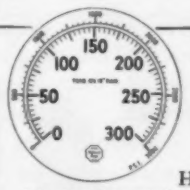
Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

TUBES BUILT FOR MILLIONS OF PRESSURE PULSATIONS

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak nor crack.



DOUBLE SCALE DIAL SHOWS TONS ON RAM AND PSI

Helicoid Gage dials are supplied in jet black with white figure markings or in dull white with black figure markings. They are constructed of laminated phenol with a transparent plastic surface and the longest possible scale length for more accurate readings. They are non-corroding, will not discolor nor fade and will not crack, chip nor peel.

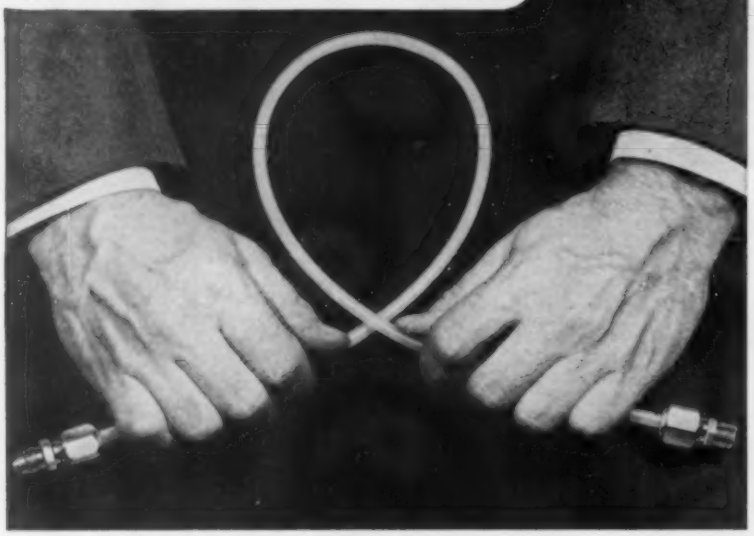
Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-H Connecticut Avenue • Bridgeport 2, Connecticut

ACCO
A C C
TRADE MARK

Helicoid gives you all these features at prices that are competitive in the quality gage field

NYLAFLOW® PRESSURE TUBING



NOW...a flexible plastic tubing with properties of rigid metals

Time and again Nylaflow Pressure Tubing has *proved* it will stand up under really severe service conditions . . . outlasting metallic systems and reducing costs.

Here is a tough, horn-like structure extruded from polyamide resins. Nylaflow is light and flexible for remarkable ease of installation. But it is also strong with high burst strength and abrasion and impact resistance . . . Where can you use with profit this unique material that combines these unusual properties:

NYLAFLOW's Outstanding Characteristics

- High pressure rating at low cost.
- Exceptionally high resistance to flex and vibrational fatigue.
- Mechanically strong—resists abrasion and impact.
- Corrosion resistant, unaffected by oils, hydraulic fluids, carbonic acid, alkalies and most solvents.
- Odorless, tasteless, non-toxic, non-corrosive, fungus resistant.
- Will not embrittle in storage.
- Serves wide temperature range: as low as —100°F., up to +225°F.

Easy, rapid installation

- Use with standard metallic flare and compression fittings.
- Flexibility eliminates pre-bending, flexible couplings, intermediate fittings.
- Can be installed and fastened around existing equipment.
- Form stable, can be permanently pre-bent with heat.

Latest information on Nylaflow Pressure Tubing is available in a new bulletin which covers installation, properties, characteristics and applications. For your copy fill out and mail coupon today.

THE POLYMER CORPORATION OF PENNA.
Reading, Pa.
Export: Polypenco, Inc., Reading, Pa., U.S.A.

POLYPENCO nylon, POLYPENCO Teflon†, NYLAFLOW® and NYLATRON® GS — †DU PONT TRADEMARK

POLYPENCO

THE POLYMER CORPORATION OF PENNA.
Dept. AH-57
Reading, Pa.

☐ Please send me new bulletin on NYLAFLOW Pressure Tubing
☐ I have this use in mind: _____

Name _____ Position _____
Company _____
Address _____
City _____ Zone ____ State _____

LETTERS to the editor

to 3000 psi. Also, will you please send me a list of manufacturers of pressure transducers.

IRVING HAZARD
Project Engineer
Inland Testing Laboratories
1457 Diversey Parkway
Chicago, Ill.

The information has been forwarded.

Quick Disconnects

We found a solution to one of our problems in Mr. F. Ecker's article in your March issue, *How Martin Cut Hose Test Costs.* Being in the aircraft idustry, our requirement is similar to that of Glen L. Martin Co., with the additional work of 100% check on all solid as well as flexible hydraulic, oxygen and pneumatic lines. The quick disconnects Mr. Ecker described were exactly what we had been looking for to meet our requirements.

C. CARVER
Supervisor
Production Engineering Dept.
De Havilland Aircraft of Canada, Ltd.
Toronto, Canada

Metal O-Rings

In the May issue of APPLIED HYDRAULICS, there was an article entitled: "Static Sealing With Metal O-Rings." We are interested in obtaining further information on this type O-ring, and would appreciate names and addresses of companies that manufacture this product.

H. J. JUNGBLUTH
Purchasing Agent
Oilgear Company
1560 West Pierce St.,
Milwaukee, Wis.

Company names have been sent.

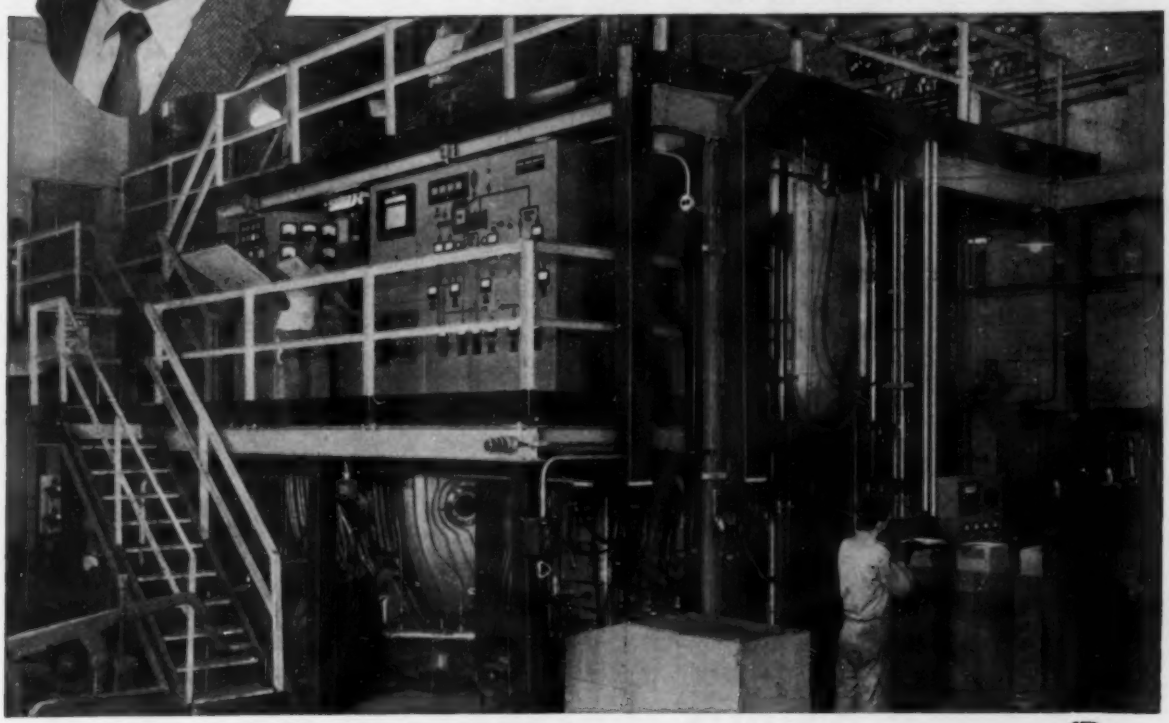
Hydrostatic Test Fixture

If available, I would appreciate receiving detailed dimensional prints of the adapter shown in figure 3 of Hydrostatic Test Fixture, page 127, APPLIED HYDRAULICS, Sept., 1955. I also would appreciate receiving tear sheets or

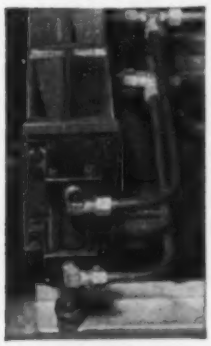
Continued on page 18

"Our experience demonstrated that hydraulic line rupture can occur in proximity to molten metal without fire when Cellulubes are used . . ."

Mr. Arthur E. Franks of Vacuum Metals Corporation, Syracuse, N.Y.



". . . this is why fire-resistant Celanese Cellulube hydraulic fluid is in use in the world's largest vacuum furnace at Vacuum Metals Corporation."



Hydraulic Controls on the world's largest vacuum furnace

In designing the hydraulic controls for its 2500-pound vacuum melting furnace, Vacuum Metals selected Cellulube hydraulic fluid because of its fire resistance and low vapor pressure characteristics. Laboratory tests and operating experience demonstrated that the unique combination of Cellulubes' properties made it the ideal material for this application.

These findings are typical of Cellulubes' performance during continuous operation under critical conditions. As hydraulic fluids, Cellulubes reduce the dangers of fires and explosions caused by line breaks or other equipment failures. As air cylinder lubricants, Cellulubes prevent the formation of excessive carbon deposits—the main source of compressor fires and explosions.

Available in 6 controlled viscosities, Cellulubes can be supplied to meet exacting requirements in the replacement of flammable fluids presently in use. Play it safe, write for complete data and technical assistance. Celanese Corporation of America, Chemical Division, Dept. 588-H, 180 Madison Ave., N. Y. 16.

Celanese®
Cellulube®

Celanese CHEMICALS

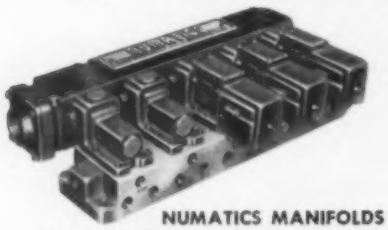
Specify **NUMATICS VALVES**

. . . there are no "equivalents"

SAFETY. . .

surpassing any other air valve on the market

In a momentary contact valve application, safety . . . for operator and machine alike . . . depends on a valve that will not shift when de-energized. Numatics DSA4 valves *can't* shift. Numatics exclusive detent does the trick . . . it safely, positively locks the valve spool in position the split second the valve is de-energized. What's more, this locking action is independent of air pressure, friction or packing drag. Numatics momentary contact air valves are, *in fact*, safer, more dependable than any other valves currently on the market. Write for complete information today.



NUMATICS MANIFOLDS
Numatics individual exhaust and conduit manifolds provide perfect "running mates" for Numatics solenoid actuated valves.

4-WAY HAND VALVES
For the utmost reliability and versatility, look first to Numatics 4-way hand valves. 136 models in 4 pipe sizes, a valve for every application.

NUMATICS, Inc. MILFORD, MICHIGAN
Dept. AH

LETTERS to the editor

references pertaining to high-pressure, 6000 lbs max, hydrostatic testing of tubing. I am interested in test head design, hold downs and intensifiers.

R. O. BREUER
Supt. of Engineering
Phelps Dodge Copper Products Corp.
Los Angeles, Calif.

Detailed drawings of the adapter used on high-pressure hydrostatic tube test equipment are not available. The cross-sectional drawing shown in the article is quite complete, and we are sure you could work out dimensions for your own specific application. We have included the names of companies that have developed valves and intensifiers for hydrostatic testing of tubing.

Circuit Symbols

We would like to have eight or more copies of your booklet Know Your Component Symbols For Hydraulic Circuits.

W. E. MORLEY
Head of Machine Development
National Carbon Co.
Div. of Union Carbide & Carbide Corp.
Fostoria, Ohio

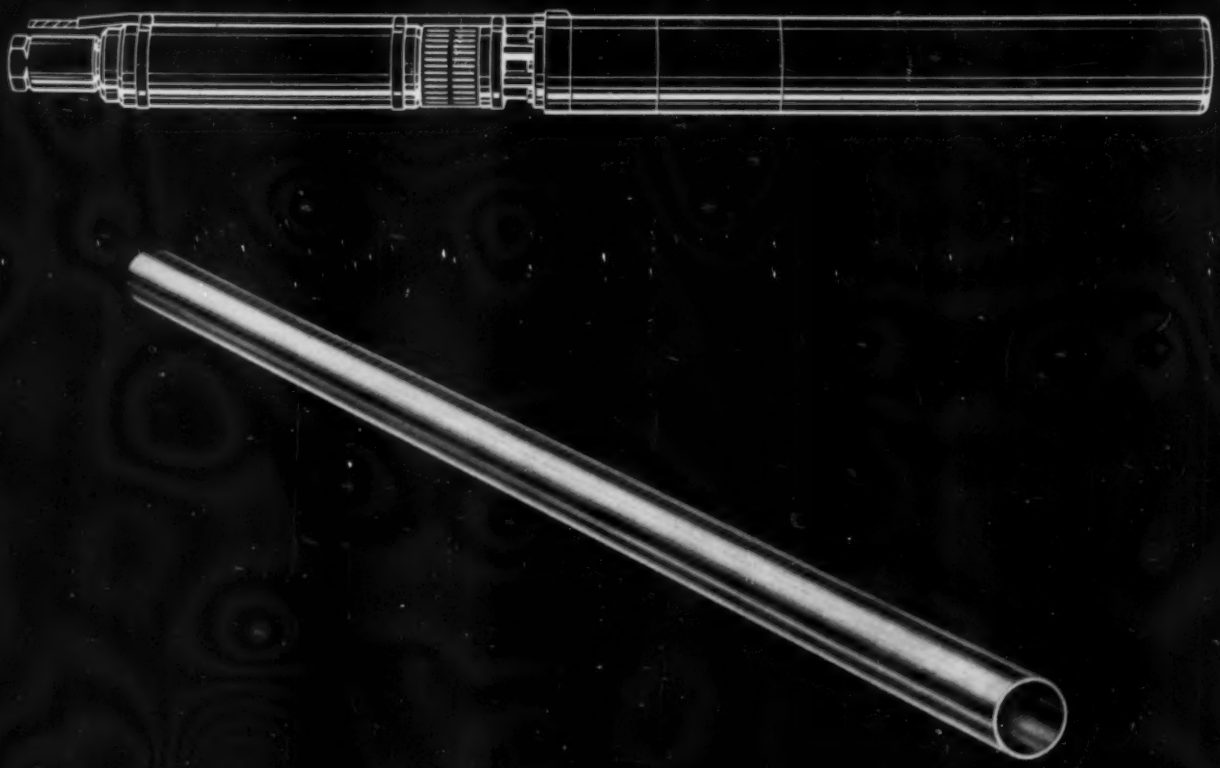
This booklet is no longer available. However, in the January 1957 issue we published a 32-page booklet Air & Oil Circuit Guide, providing extensive information on hydraulic symbols and circuits. Copies are available at 50c each.

Product Selection Guide

Since the January 1957 issue of APPLIED HYDRAULICS is no longer available, may we have your permission to reproduce a number of copies of the Product Selection Guide which appeared in this issue? We require these in our engineering department.

MARY M. COLVIN
Supervisor
Library Section
Aro, Inc.
Tullahoma, Tenn.

You have our permission to reproduce the copies you require. The January 1958 Designers' Guide issue is now being prepared. ▼▼▼



B&W ERW Mechanical Tubing Saves Time, Cuts Pump Production Costs 50%!

One manufacturer of submergible pumps had a bottleneck in its production line. The company had been using seamless tubing for their motor housings and pump housings—the design of the units called for precision tubing with close I.D. tolerances.

The company turned to B&W Electric-Resistance-Welded Mechanical Tubing.

After two years of using this close tolerance tubing, company engineers estimate they have been able to reduce their production costs on the components as much as 50%. What's more, the production of these parts has become the least troublesome in the manufacturing process!

Here's another example pointing out where B&W ERW Tubing is being used by industry to produce better products at lower cost. B&W Mechanical Tubing is available in a wide range of sizes, shapes, analyses, and finishes.

Get all the facts on savings from Mr. Tubes, your link to B&W. Call your local B&W tubing distributor. Write for Bulletin TB-419. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA-6088-M4

Seamless and welded tubular products, seamless welding fittings and forged steel flanges — in carbon, alloy and stainless steels

Circle 15 on Reader Service Card

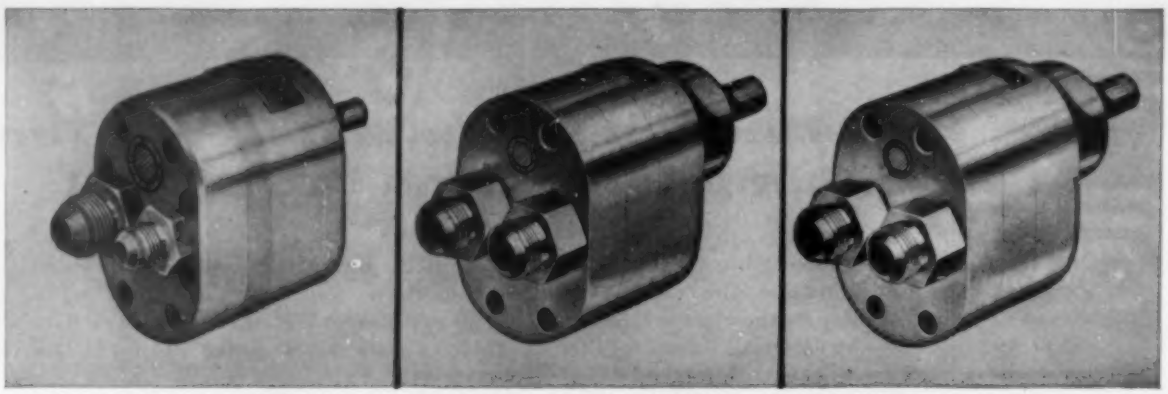
specify with confidence...

HYDRAULIC PUMPS FLUID MOTORS

Design engineers have confidence when they specify dependable Eastern Hydraulic Pumps and Fluid Motors. Exclusive Eastern features create an economical, reliable, and compact unit for the heart of your hydraulic mechanism.

Lightweight construction of aluminum alloy housing, nitralloy gears and shaft, and close tolerances assure longer service, higher volumetric efficiency, and more dependable operation. Various types of mountings are available for space saving installation.

In many cases by specifying an Eastern unit you realize dollar savings as well as great savings in size. They cut operating costs by keeping space requirements and weight to a minimum.



100 Series — Heavy duty gear pump. Delivery from .1 to 5 gpm and working pressures up to 1,500

700 Series — High pressure gear pump. Delivery from .6 to 9.6 gpm and pressures up to 1,500 psi.

2700 Series — Gear type fluid motor. Torque output — 0 to 15 ft. pounds.

Send for Eastern Hydraulic Catalog F-800. Contains valuable engineering diagrams and information.

Eastern INDUSTRIES, INC.

100 SKIFF ST. HAMDEN 14, CONN.

Uniform industrial O-rings promptly—anywhere!

National O-rings are stocked in major cities coast to coast. Large quantity orders are filled quickly from factory warehouses; smaller quantities are readily available from convenient distributor stocks. In every case, you and your customers are assured of exact uniformity in compound, finishing, durability and performance.

When special O-rings are needed, National's experienced engineers and large manufacturing facilities are at your immediate service.

Find out about National O-rings. Just call or write any National district sales office for O-ring data, engineering service, or the name of your nearest National O-ring supplier.

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Redwood City and Downey, California

4541

National District Sales Offices:

Chicago, Ill.
Room 462, McCormick Building
HArrison 7-5163

Cleveland, Ohio
210 Heights Rockefeller Bldg.
YEllowstone 2-2720

Dallas, Texas
2520 West Mockingbird Lane
FLeetwood 2-7541

Detroit, Mich.
13836 Puritan Avenue
VErmont 6-1909

Downey (Los Angeles Co.), Calif.
11634 Patton Rd.
TOpaz 2-8163

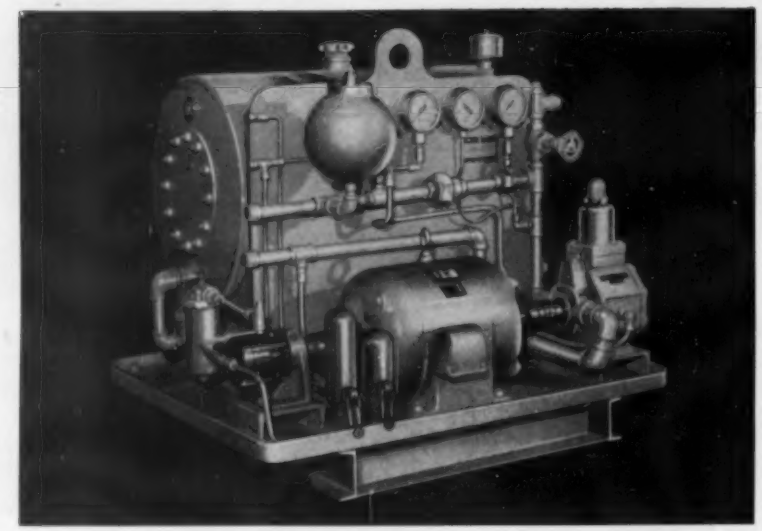
Indianapolis, Indiana
2802 North Delaware St.
WAlnut 3-1535

Milwaukee, Wis.
647 West Virginia St.
BRoadway 1-3234

Newark, N. J.
1180 Raymond Blvd.
MItchell 2-7586

CATALOGS IN SWEET'S

Circle 74 on Reader Service Card



Complete POWER and CONTROL SYSTEMS... *ready to connect*

SIMPLEX Engineering Company has many years of experience in co-ordinating the hydraulic principles, for all industrial applications. We have always freely utilized all types and makes of hydraulic equipment available throughout the industry. Our ability to design and build hydraulic power units of every description has enabled us to thoroughly satisfy all customer requirements, regardless of pressures, volumes, or circuits.

This vast background of hydraulic "know how" is available to all SECO *customers. We invite you to outline to us any special project.*

STANDARD *Power Package Units*

SECO

We build 26 *standard* power package units —suitable for a wide range of requirements, and ready to connect to the press or other mechanism to be operated. These *standard* units provide volumes of ½ to 10 G.P.M., and pressures from 500 to 10,000 PSI. Use the coupon below for complete information on these *standard* power and control units.

SIMPLEX ENGINEERING CO.
Zanesville, Ohio

Please send me complete information on SECO Standard power package units.

Name_____ Title_____

Company_____

Address_____

Future Events

September 9-12: SAE Tractor Meeting and Production Forum, Hotel Schroeder, Milwaukee, Wis.

September 9-13: 12th Annual Instrument Automation Conference and Exhibit of The Instrument Society of America. Public Auditorium, Cleveland, Ohio.

September 30-October 5: SAE Aeronautic Meeting, Aircraft Production Forum and Aircraft Engineering Display. Hotel Ambassador, Los Angeles, California.

October 17-18: The 14th Annual Conference on Industrial Hydraulics. Hotel Sherman, Chicago, Illinois. Raymond D. Meade is Conference Secretary.

October 23-25: Fall meeting National Fluid Power Association, Washington, D. C. For details write: Barrett Rogers, NFPA, 1618 Orrington Ave., Evanston, Illinois.

October 31-November 2: National Conference "Engineering and Scientific Education—Foundation of National Strength", sponsored by the Western Society of Engineers, Engineers Joint Council, the Scientific Manpower Commission, the National Science Foundation and the National Academy of Sciences—National Research Council. Edgewater Beach Hotel, Chicago, Illinois.

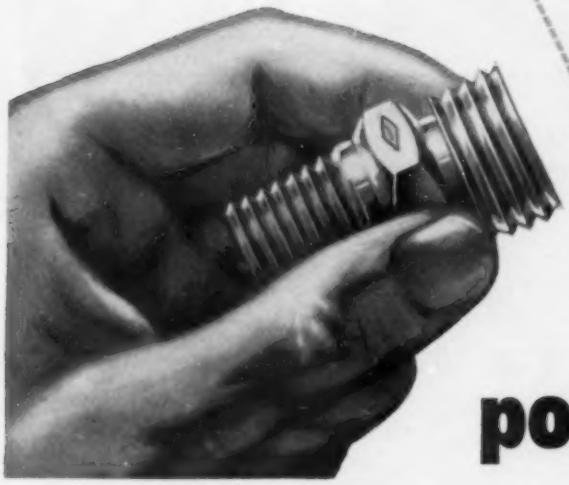
November 13-15: Eighth National Conference on Standards and 39th Annual Meeting of the American Standards Association. St. Francis Hotel, San Francisco, California.

January 13-17, 1958: SAE Annual Meeting and Engineering Display, The Sheraton-Cadillac and Statler Hotels, Detroit, Michigan.

March 31-April 2: SAE Production Meeting and Forum, The Drake, Chicago, Illinois.

April 8-11: SAE Aeronautic Meeting, Aeronautic Production Forum, and Aircraft Engineering Display. Hotel Commodore, New York, N.Y. ▼▼▼

IMPERIAL HI-SEAL™



the flareless tube fitting that makes a positive butt-joint

The most important advance in tube fittings in 20 years!

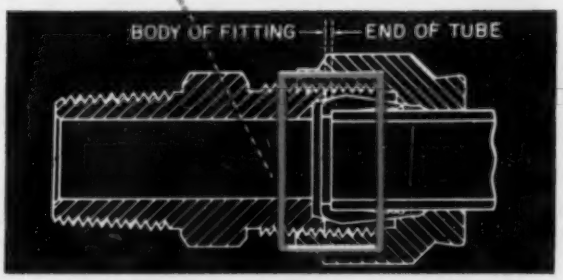
No need to spring tubing • withstands high pressures
foolproof assembly • no flaring or threading

Checks on typical high-pressure tubing jobs show you can cut installation time substantially with Hi-Seal fittings . . . *save up to 53% compared with flare-type fittings.* Hi-Seal completely revolutionizes high-pressure tubing installations!

Foolproof assembly! Pressure-tight joints and re-connections can be made even by the inexperienced. There's only *one* way tubing can be inserted into sleeve . . . only *one* way sleeve goes into fitting.

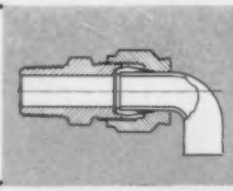
Positive butt-joint! No tube entry into body of fitting. No springing of tube. Especially important with large-diameter, heavy-wall, hard-temper tubing, or short lengths of tubing.

Closer tube bends! Butt-joint and no-flaring features mean bends can be made exceptionally close to end of tubing. Hi-Seal fittings work in close quarters where other types of fittings cannot be used!



See above how tube "bottoms" on shoulder of sleeve. Camming action of nut causes sleeve to form a collet-type triple-seal grip on tubing. Final circumferential seal is made by tapered edge of sleeve. No tube torquing when making a joint.

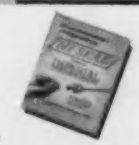
MEETS J.I.C. AND A.S.M.E. STANDARDS LISTED BY U.L.



Permits Closer Tube Bends Than Any Other Fittings!

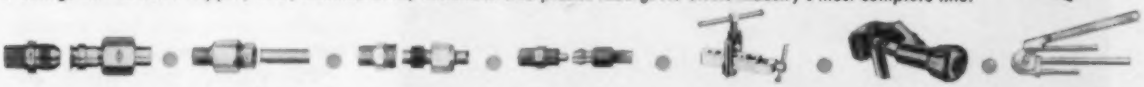
Hi-Seal fittings are furnished in steel and stainless steel — for ⅛ to 1½" O.D. tubing.

Write for Bulletin 3061 and complete facts.



SEE YOUR IMPERIAL DISTRIBUTOR:

for fittings and tools for copper, steel, stainless steel, aluminum and plastic tubing. He offers industry's most complete line.



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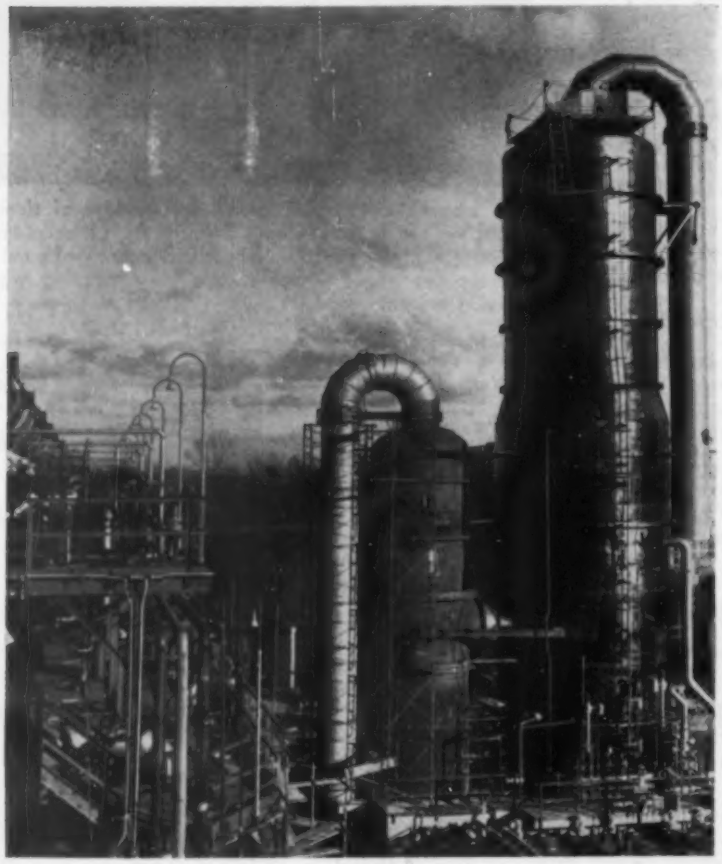
BRIEFS about fluid power

ALL-HYDRAULIC FLOW-CONTROL SYSTEM . . . used in chemical processing

An all-hydraulic control system is now being used for the automatic operation of product valves in a new, multi-million-dollar processing plant built by the Texas Butadiene & Chemical Corp., Houston. In laying plans for the new plant, the company's goals were: (1) faster operation, (2) higher output, and (3) lower production costs. They also wanted greater control over the flow of butadiene ingredients into reactors than possible with conventional motor control. When the plant designers decided to use hydraulics, they consulted Rivett, Inc., Boston.



• **Requirements**—The processing of butadiene, used in synthetic rubber and some plastics, requires precise control of ingredient flow volume and velocity; plus sequencing of ingredients into reactors. Electric motor control lacked flexibility needed to compensate for changes in product viscosity. To gain flexibility and increased operating speeds with motor control would have been too expensive and unwieldy. Fluid power, however, provided precise and flexible control over product flow, plus simplified operation, a central power supply, lower initial cost, and lower operating cost. Only one source of power is required—at the central power unit—reducing the estimated 400 to 500 hp necessary for electrical control to 30 hp required by the hydraulic system.

• **System**—The product gate valves are operated by small hydraulic cylinders. The cylinders are operated by solenoid valves located at the central control panels. Gate valve sizes handled by the system range from 4 to 30-in. Operating times for the gate valves are as low as one second for smaller valves, and four seconds for the larger ones.

The system's gate valves are actuated by independently operated control units. Each unit regulates seven reactor vessels. To

Continued on page 26

Bet your boots we make 'em

Steering knuckle drag link boot
Universal joint cover
Bellows cover for sliding ways
C/R
Coated fabric cylinder rod boot
Hydraulic jack cylinder rod boot

Custom-designed and engineered to fit mechanical giants or midgets

Whether you want a boot two stories high . . . or no bigger than your thumb . . . let C/R Sirvis engineers solve the problem for you. They're specialists . . . backed by 78 years' experience . . . with unusual skills and ingenuity in the development and manufacture of mechanical boots. They'll design and produce a C/R Sirvis boot to your exact requirements in any size, any quantity . . . using only the finest materials: mechanical leather, selected, tanned and treated by C/R . . . nylon . . . or elastomer-coated fabric. The absolute dependability of your boot will be proved before production.

So, whenever your problem involves the protection of eccentric, reciprocating or universal action . . . call on C/R. Write us for complete information.

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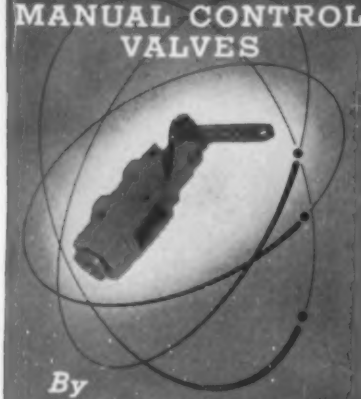
MANUAL CONTROL VALVES



By
M.C. MFG. CO.

The one shown is:
MC 1888 VALVE — AIR CONTROL, THREE PORT
fulfilling the following aircraft specifications:

FLUID: Air or Nitrogen
PRESSURE RANGE: 0 to 3000 psi
TEMPERATURE RANGE: —65°F to +225°F
FLOW FACTOR: F=.07
PORT CONNECTIONS: Per AND 10050-4
INTERNAL LEAKAGE: 3 cc/hr. max. with 3000 psi at pressure port.
EXTERNAL LEAKAGE: Zero
WEIGHT: .5 lbs.
MILITARY SPECIFICATION: Applicable paragraphs of MIL-P-5518 and MIL-P-8564

Hydraulic and Pneumatic Components for the Aircraft Industry

VALVES OF ALL TYPES: Relief • Solenoid • Manual Control • Transfer • Shuttle • Brake • Control • Fluid • Pressure Reducing • Restrictor and Special

ALSO: Air Compressors • Fuel Pumps • Dehydrators

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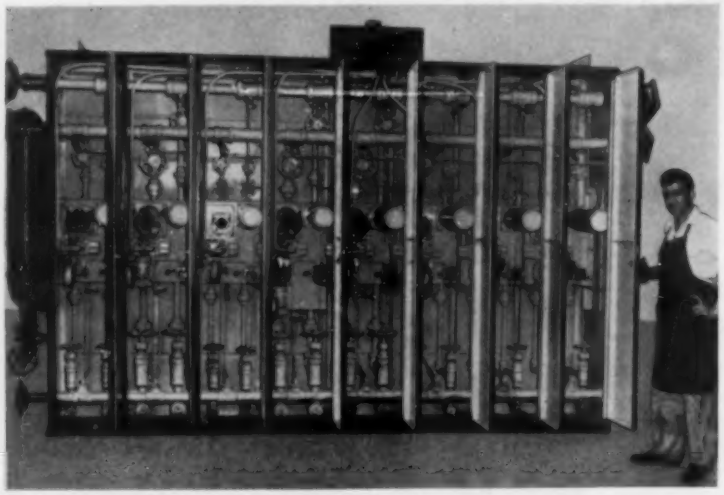
BRIEFS continued

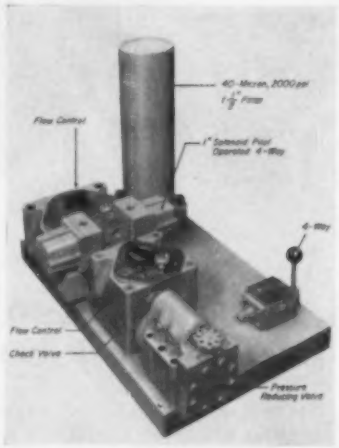


Complete, encased hydraulic control unit for operating seven gate valves of one butadiene reactor vessel. Eighth panel operates reactor by-pass valve in case of emergency.

simplify operation and keep piping and electrical wiring to a minimum, common steel mounting panels with drilled interconnections were designed for each gate valve circuit. All valves and filters for operating each gate valve are mounted on these panels. The panels for each reactor were then grouped and installed in a specially made, weather-resistant cabinet, with a separate door for each valve circuit. One of the cabinets in each unit contains an eighth panel with a circuit to operate a reactor bypass valve, for use in an emergency.

Power unit for the system includes two electric motor-driven, positive-displacement pumps, with a third stand-by steam turbine driven pump. Gate-valve cylinders are controlled by solenoid-operated four-way valves.

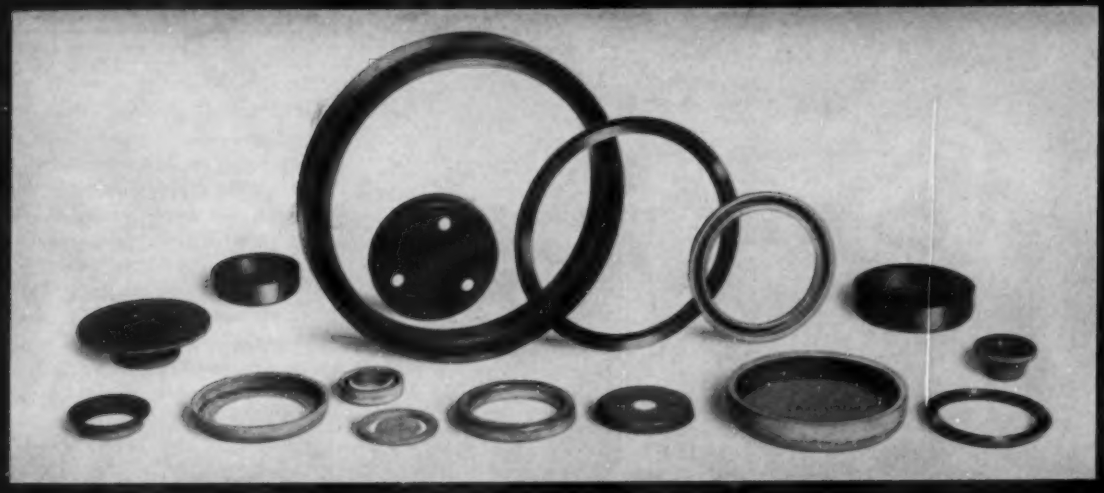
To satisfy instantaneous horsepower demands during the system's 20-minute cycle, and to reduce over-all horsepower requirements, the system includes a total of ten 10-gallon hydro-pneumatic accumulators. These discharge about 20 gallons of oil every three minutes, the peak output required by the circuits.

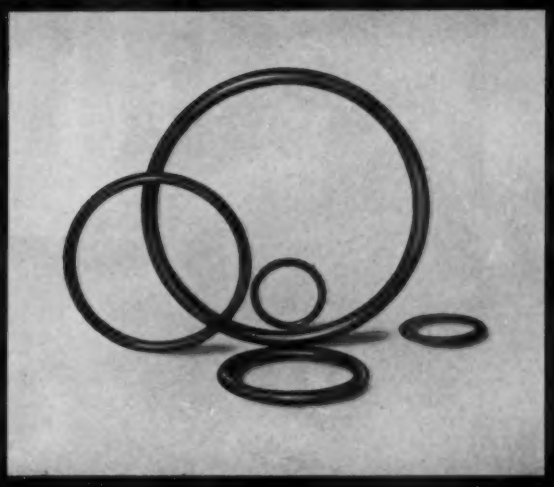


Panel-mounted valve and filter assembly controls one of seven cylinder-operated gate valves on each butadiene reactor.

High-pressure oil from the power unit enters the panels and flows through 40-micron, 2000-psi filters to the 4-way valves which control the flow of oil to the gate valve-actuating cylinders. As these double-end-rod cylinders move to open or close the gate valves, the exhaust oil flows from the tank ports of the 4-way valves through pressure-compensated, flow-control

Continued on page 28





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Today, in addition to complete facilities for these leather packings, G & K can furnish synthetic packings . . . cups, flanges, U's, V's, etc. *More*, G & K offers a complete line of synthetic O-rings.

For your mechanical sealing problems, check with your G & K representative.

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positive, automatic PRESSURE CONTROL
you can depend on

FULFLO piston type, oil-relief hydraulic by-pass valves are designed and built so you can install 'em, then forget 'em! They are quiet, non-chattering because of shear-closing action. Low price and high quality, make Fulflo Valves a wise choice for O.E.M. use . . . replacement too! Available with "O" Ring or Gasket Seal.

- **Standard and Flanged models**
- **Just 6 springs for pressures to 500#**
- **Cast iron or brass bodies**
- **Brass, steel or stainless pistons**
- **Pipe sizes to 2½"**
- **SPECIALS to your requirements**

FULFLO

WRITE FOR "Fulflo Valves Mechanical Data Book", free helpful reference.

THE FULFLO SPECIALTIES CO., INC.
415 Fancy Ave., Blanchester, Ohio

BRIEFS continued

valves. By using these valves in the exhaust outlet, cylinder speeds are the same in both directions.

One of the major problems was the need for lower pressures to close, and higher pressures to open the product gate valves in order to avoid seat jamming. This problem was overcome by connecting the "close" cylinder port to a pressure-reducing valve. When the valve is closed, a reduced force is maintained.

Meter-Out Speed Control

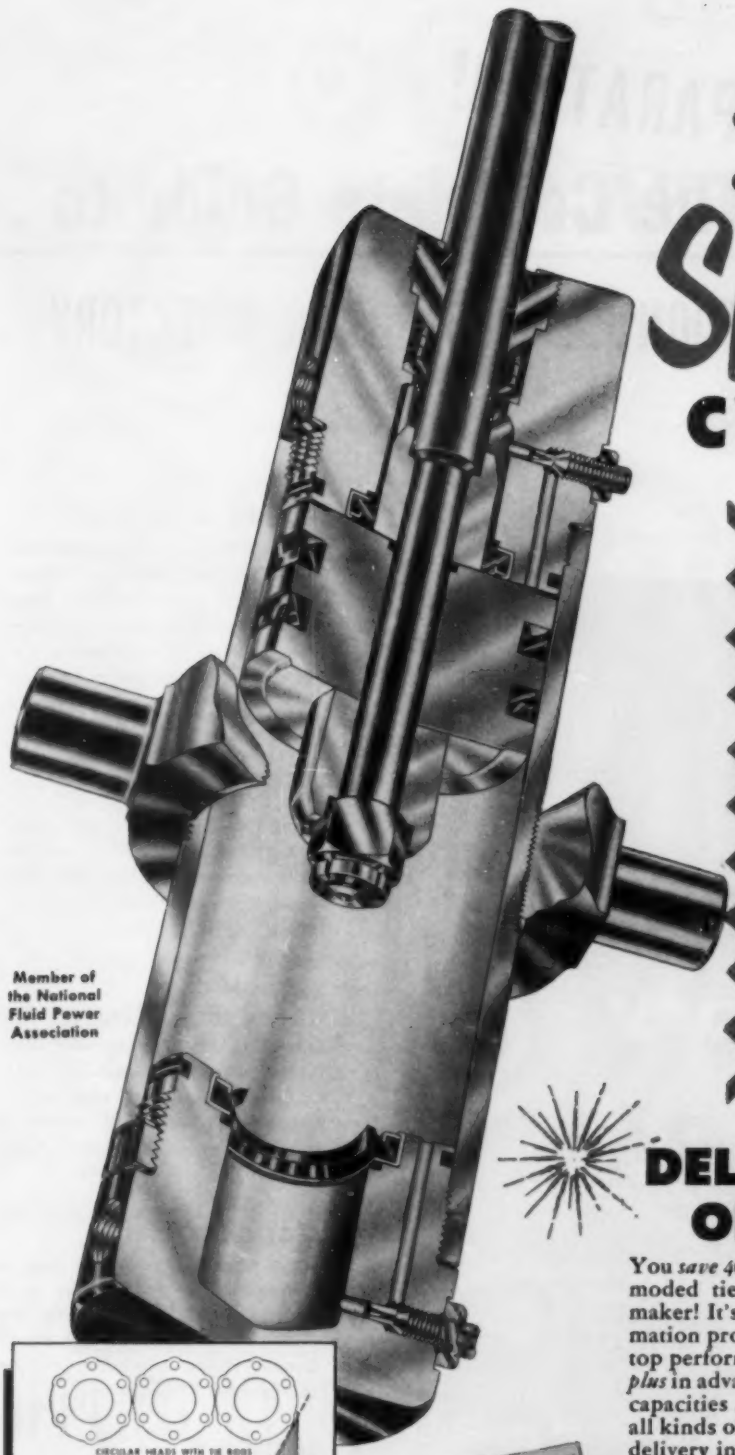
Two-inch bore by 4 or 8-in. stroke cylinders are used to operate the small product valves, those operating the larger valves are 6-in. bore by 32-in. stroke. One valve in each reactor requires a long, slow opening. To accomplish this, the designers installed a second flow-control valve with a free-return-flow check between the 4-way and pressure-reducing valves. The opening speed is thus controlled by metering exhaust oil from the cylinder.

Hydraulic fluid filters were installed to assure trouble-free operation during the plant's 24-hour per day schedule. Suction and return filters were used in the central power unit, and a magnetic basket was put in the reservoir. High pressure filters were also designed for each valve control panel.

The entire job required over 500 valves and filters. All wiring, piping, and initial testing was completed at the Rivett assembly plant before shipping. Only the field piping was necessary before the installation was ready for operation. Control wiring and size of installation were reduced to approximately 1/10 that required by a similar electrical control system. Rate of gate valve travel is easily varied at any point in the stroke, and slow starts or stops can be achieved by external valving. In addition, the actual operating forces required to open or close the main gate valves can be varied by adjusting the relief valve. ▼▼▼

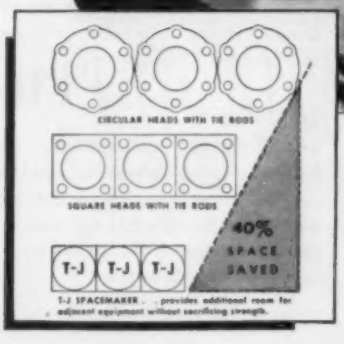
Circle 43 on Reader Service Card

all the EXTRAS are standard with T-J Spacemaker CYLINDERS



- **NEW** *exclusive* ingenious cushion designs . . . Super Cushion Flexible Seals for Air . . . New Self-Aligning Master Cushion for Oil.
- **STRONGER** than outmoded tie rod design, proven through actual tests. No tie rods to stretch.
- **SOLID STEEL HEADS** throughout the full line.
- **COMPACT DESIGN** eliminates tie rods, increasing the strength and reducing mounting space required, providing extra room for adjacent equipment.
- **HARD CHROME PLATED** body bores and piston rods . . . assure you of long trouble-free service. (Standard at no extra cost.)
- **METALLIC ROD SCRAPER,** not just a wiper, actually removes foreign matter from the rod.
- **PILOTED PACKING GLAND** with extra long bearing. Additional strength and support to the piston rod.
- **OIL** pressure to 750 p.s.i. AIR to 200 p.s.i.

Member of the National Fluid Power Association



DELIVERY OFF THE SHELF!

You *save 40% space* when you switch from outmoded tie rod cylinders to the T-J Spacemaker! It's stronger, too! Fits right into automation programs in countless plants. Delivers top performance and dependability with a big *plus* in advanced features. Wide range of styles, capacities . . . reduces man-hours and costs in all kinds of push-pull-lift operations. Off-shelf delivery in 64,000 combinations!

NEW LITERATURE—Send today for new Catalog SM56 with complete engineering details on Spacemaker line. Write The Tomkins-Johnson Co., Jackson, Mich.

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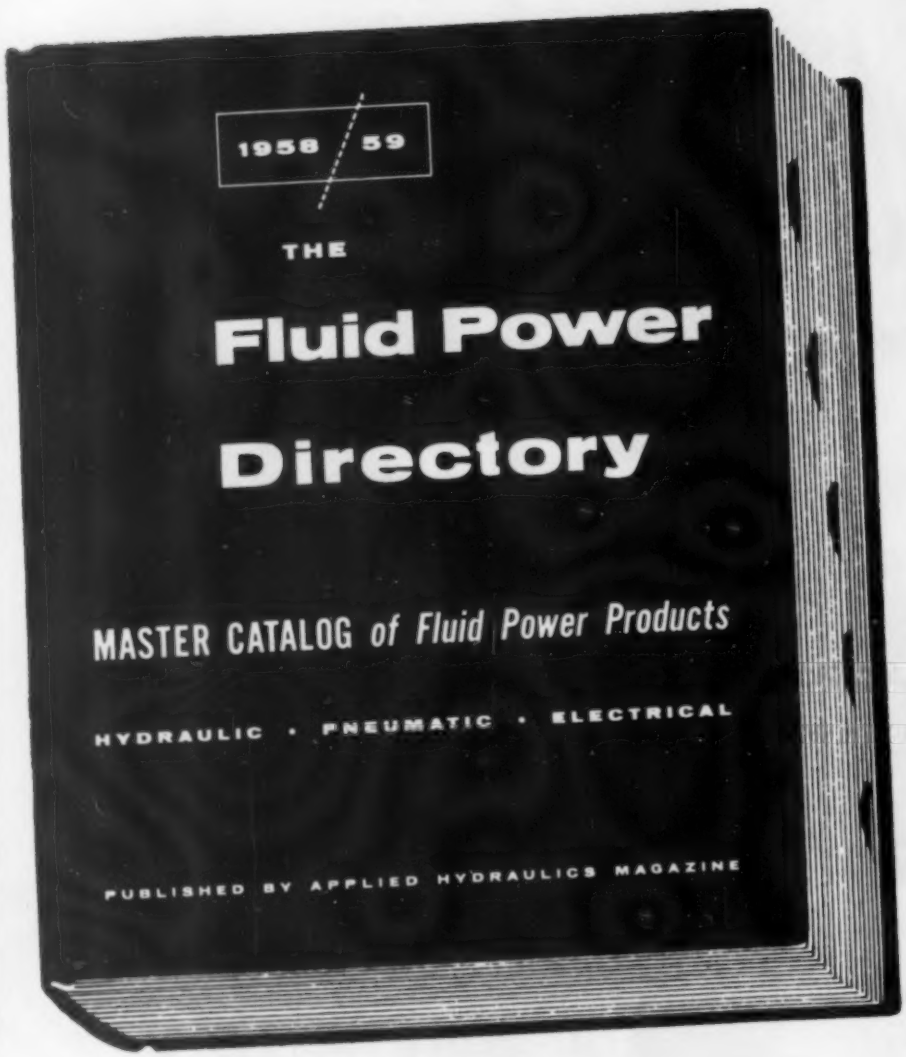
The Complete Guide to . .

2nd EDITION . . . FLUID POWER DIRECTORY . . . .



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FLUID POWER COMPONENTS DIRECTORY—Over 140 pneumatic, hydraulic and electrical products for fluid power systems—from accumulators to wiper rings—are listed in this directory. Listings of advertisers appear in bold face along with the note "See Catalog Section C, pages——— to ———".

SECTION B

TRADE NAMES—Alphabetical listing of product trade names gives manufacturers' names and addresses. Bold asterisk points out all advertisers in the Directory.

SECTION C

MANUFACTURERS' CATALOGS AND SALES OUTLETS—Manufacturers' advertising is arranged in alphabetical order. An index to these specification ads lists manufacturer's name and address of main plant; names and location of U.S. and Canadian representatives.

SECTION D

FLUID POWER DESIGN—224 pages of engineering reference material is divided into: JIC and ASA Standards, Nomographs, Design Data, Air and Oil Circuits. Product Information, and Applications and Developments.

SECTION E

WHERE TO BUY LOCALLY—The "Yellow Pages" supply information about local fluid component suppliers. Listing is alphabetical by state, city and company name. Advertisers in this section are independent sales companies.

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The only complete Hydraulic and Pneumatic Reference

YOUR HANDBOOK FOR FLUID POWER —This biennial volume—the 1958/59 edition—will be available October 28th. Since June 1955, the editors of APPLIED HYDRAULICS have been gathering and editing hydraulic and pneumatic information for this book. You will use the new edition of the FLUID POWER DIRECTORY as a time saver for all kinds of information about hydraulics and pneumatics.

The Components Directory Section lists more than 650 companies who manufacture products in the 140 indexed classifications from accumulators to wiper rings.

In this permanently bound volume, more than 150 manufacturers of fluid power components put their specification-type advertising in your hands—many will include condensed catalog information. Your 1958/59 Directory warrants being called the "bible" of fluid power application and engineering.

FOR ENGINEERS WHO USE FLUID POWER —When you're looking for sources of components, or trying to locate the manufacturer of a part for which you have the trade name, or want to quickly locate the local source, or need spec data immediately, it's all in this book. And you have a big PLUS section which is only available in this volume—224 pages of Fluid Power Design information. It includes JIC and ASA Standards, nomographs, charts, product information, over 150 circuits, applications and developments.

UP-TO-DATE INFORMATION —17,500 1958/59 Directories will be put in the hands of men who select fluid power components. A recent survey made to users of the first edition published two years ago shows that each copy is used by more than 5 men. The book is designed for the hard use it gets. It helps every user save time in designing and building fluid powered equipment. Your copy will be your fluid power handbook.

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The Magazine of Fluid Power

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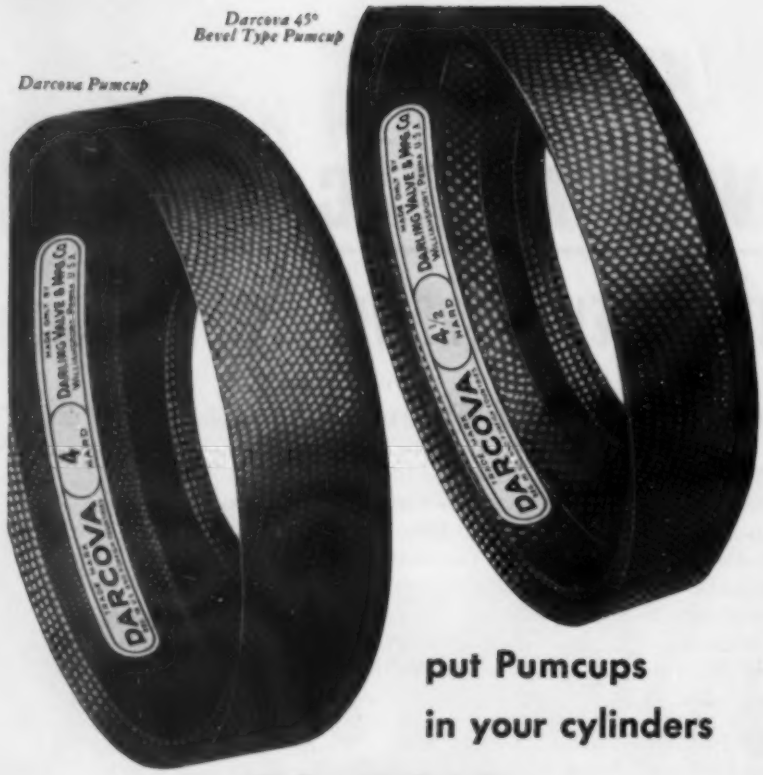
Darcova 45° Bevel Type Pumcup

Darcova Pumcup



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TO HOLD PRESSURE LONGER!

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Unlike ordinary piston packing, precision Pumcups are engineered to minimize friction load while hugging cylinder walls on every pressure stroke. Regardless of eventual wear, efficiency *stays* high! So there's far less down-time and need for replacement.

Pumcups are made in a wide range of sizes, types and texture-engineered compositions, including 100% Nylon, for all kinds of pressure-temperature-fluid conditions. Send for Pumcup Bulletin 5503 and weigh all the facts!

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DARCOVA
THE ORIGINAL COMPOSITION CUP
TRADE MARK
PUMCUPS

BRIEFS / continued

Recent Publications

Survey of Research Projects in the Field of Aviation Safety, Sixth Annual Supplement: prepared by Cornell-Guggenheim Safety Center 468 Fourth Ave., New York City. The Safety Center is trying to help solve "the most important problem in aviation"—air traffic control. They feel that air traffic jams of the not-too-distant future will rival the snarl now present on our highways. The survey should be of interest to anyone in the aircraft field. Two of the projects listed as currently under study are: 1. work on specification MIL-F for non-flammable hydraulic fluid, and 2. development of crash-resistant flammable-fluid systems.

The survey is not a bibliography of reports, but a listing of current and completed research projects affecting aviation safety. The 125-page survey is available from the Safety Center at $2.00 per copy.

High temperature, high strength bolts are being produced by Standard Pressed Steel Co., Jenkintown, Pa. The new fasteners, which are 50% stronger than stainless steel and alloy steel bolts at 900 degrees F., were developed on the high temperature testing facility pictured here.

Aircraft Hydraulics, Volume Two-Component Design: Edited by H. G. Conway. Published by Chapman & Hall Ltd., London.

Continued on page 38

Circle 35 on Reader Service Card

Circle 71 →

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NEW! ROD BUSHING SEAL . . .

1. Eliminates Shearing of "O" Ring in Re-Assembly
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NEW! SHEF SEAL AT TUBING ENDS . . .

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2. Eliminates Extrusion of "O" Ring at ANY Pressure—Teflon Sealing Ring is Backed Up by Zero Clearance Metal Shoulder.

NEW! LOCK-SEAL CUSHION ADJUSTMENT SCREW . . .

1. Eliminates Screw Projection Beyond Head and Cap — Cylinders Mount on Any Side.
2. Eliminates Manual Sealing and Locking After Flow Adjustment—Teflon Seal is Self Regulating and Self Locking.
3. Eliminates Accessibility Problems—Cushion Screw Interchangeable with Ball Check Position—Adjustable Through Small Wrench Hole Drilled in Interfering Machinery.

•du Pont trademark for its tetrafluoroethylene resin

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Turn Page For Cross Section Of SHEF SEAL

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OTHER MILLER QUALITY FEATURES

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Announces a New Space and Price Saving Hydraulic Cylinder Line

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SAVE UP TO 76% OF COST

Heavy Duty Model LH—Same Size As Ordinary Gasket Type Square Design Low Pressure Cylinders			
BORE	NORMAL RATINGS	NON-SHOCK INTERMITTENT RATINGS	YOU SAVE THIS % IN PRICE OVER STANDARD 2000-3000 PSI CYLINDERS
1½"	1500 PSI	2500 PSI	27%
2	1500	2500	27%
2½	1000	1500	28%
3¼	1500	2500	32%
4	1000	1500	35%
5	800	1200	37%
6	800	1200	43%
8	500	800	50%
10	500	800	71%
12	500	800	76%
14	500	800	*Not Available in 2000-3000 PSI*

Miller

Announces 50% More Power Per Cylinder Dollar

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3000-5000 PSI MODEL H

HYDRAULIC CYLINDERS

Same Price and Mounting Dimensions as Miller 2000-3000 PSI Hydraulic Cylinders.

BOTH LINES MADE POSSIBLE BY SHEF SEAL

Copyright 1957—Flick-Reedy Corporation

Miller - FLUID POWER DIVISION
FLICK-REEDY CORPORATION

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

OTHER MILLER QUALITY FEATURES

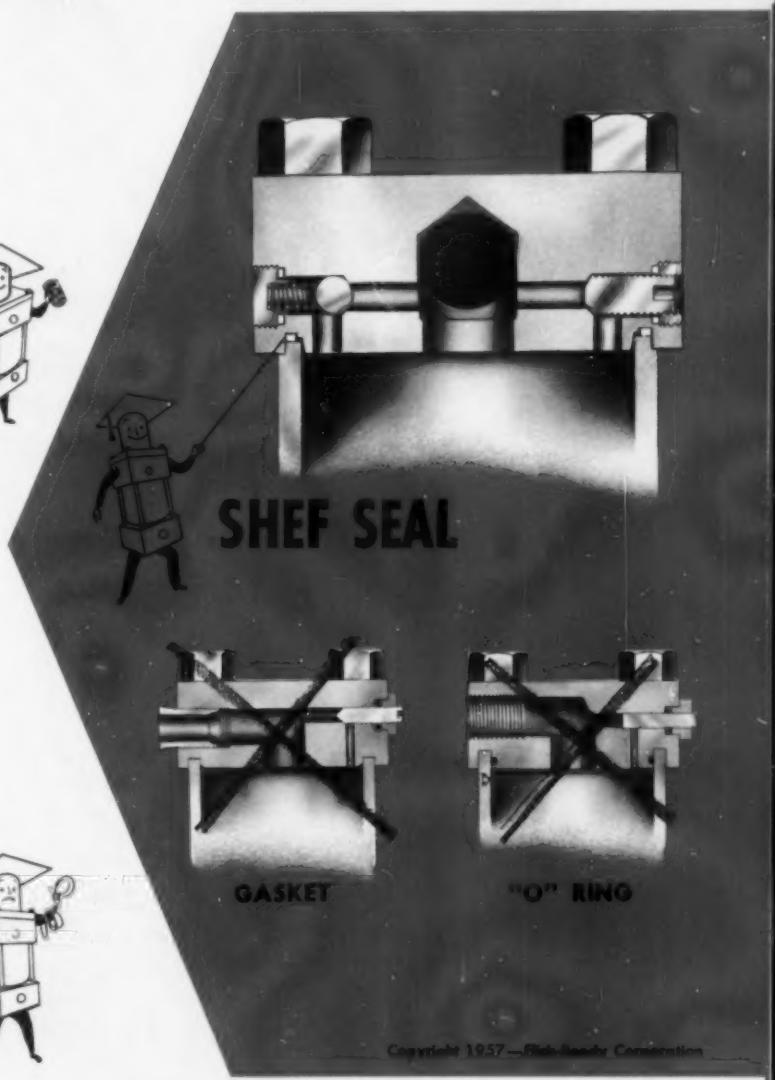
- All Teflon Sealed Against External Leakage—Teflon Cups Extra
- Case-Hardened Chrome Plated Piston Rod
- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

SHEF SEAL Obsoletes All Other Hydraulic Cylinder End Seals . . . *at no added cost*

HAS EVERY ADVANTAGE

1. Pressure Energized—Sealing Effectiveness Increased with Pressure.
2. Zero Metal-To-Metal Clearance at all Pressures Gives You Perfect Seal Backup. Sealing Ring Cannot Extrude.
3. Simplified Servicing. No "Blind" Assembly. Sealing Ring Cannot Shear.
4. Teflon* Sealing Ring Withstands All Hydraulic Fluids at Temperatures from —100° F. to 500° F.
5. Head and Cap Axial Movement Does Not Destroy Sealing.
6. Allows Air Bleed In Head and Cap for Remote or Automatic Bleeding.
7. One Sealing Ring Cross Section Dimension For All Cylinder Sizes—Supplied On Convenient Spools.
8. Zero Metal Backup Clearance Eliminates Dangerous Leaks and Spurts of Fluid Due To Seal Failure.



NONE OF THESE DISADVANTAGES

GASKET CONSTRUCTION

1. Unpredictable Results—Leaks and Blows Even at Low Pressures.
2. Outlawed by J.I.C. Eight Years Ago.
3. Seal Failure Causes Dangerous Leaks and Spurts of Fluid. Creates Unnecessary Fire and Safety Hazard.

"O" RING CONSTRUCTION

1. High Pressures and Shock Loads Expand Tubing—Increase Clearance and Cause Extrusion.
2. Blind Assembly Can Shear Sealing Ring—Difficult Servicing.
3. Seal Failure Causes Dangerous Leaks and Spurts of Fluid. Creates Unnecessary Fire and Safety Hazard.
4. Requires Large Inventory of "O" Rings
   —For Servicing Variety of Cylinder Bores.
   —For Special Synthetic Rubber Compounds To Meet Ever Changing Fluid and Temperature Needs.

*du Pont trademark for its tetrafluoroethylene resin.

Copyright 1957—Fluid Power Corporation

When you buy Miller ... You buy extra years of worry-free Cylinder performance ...at competitive prices

SHEF SEAL—*Another Miller "First"*

S SHEAR PROOF
H HEAT PROOF
E EXTRUSION PROOF
F FLUID PROOF
SEAL
Teflon Pressure Energized
Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR

OTHER MILLER QUALITY FEATURES

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- Shear Proof Rod Bushing Seal
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

Miller - FLUID POWER DIVISION
FLICK-REEDY CORPORATION

Turn Page For More About MILLER

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

Miller

All Teflon Sealed —Perfect Sealing for Hydraulic Cylinders

HAS EVERY ADVANTAGE...

Teflon—As Static and Dynamic Seals

1. Impervious to Every Hydraulic Fluid Including Fire-Resistant Types.
2. Seals Perfectly in Cylinders at Temperatures from —100° F. to 500° F.
3. Can Be Molded Into Shapes That Have Zero Leakage—Hold Pressure Indefinitely.
4. With Proper Design of External Seal Cavities, Teflon Can Be Included *Without* Increasing Prices. Miller Provides Teflon for all External Seals at Prices Competitive with Ordinary Cylinders. Leather Internal Piston Cups are Standard (Teflon Cups Extra).

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Printed in U.S.A.

edu Pont trademark for its tetrafluoroethylene resin.

When you buy Miller
You buy extra years
of worry-free
Cylinder performance
...at competitive prices

NONE OF THESE DISADVANTAGES

Synthetic Rubber— As Static and Dynamic Seals

1. Unsatisfactory Except When Used With A Limited Range of Hydraulic Fluids.
2. Even Uncontrollable Changes in Fluid Additives Often Destroy Seal.
3. Specific Compounds Needed for Compatibility with Specific Fluids Normally Used Today.
4. Normal Temperature Range Limited to 0° F. to 130° F. Slightly Reduced Life When Operated at 130° F. to 150° F. Greatly Reduced Life at 150° F. to 250° F.
5. External Leakage Causes Fire and Safety Hazards When Temperature or Fluid Destroys Seals.
6. "U" Type Seals Without Mechanical Retainer at Mid-Section Frequently "Roll" and Lose All Sealing Ability.

Resin Impregnated Leather— As Dynamic Seals Only

1. Is Compatible with Many—But Not All—Hydraulic Fluids and Additives Including a few Fire-Resistant Types.
2. Normal Temperature Range Limited to —60° F. to 130° F. Slightly Reduced Life When Operated at 130° F. to 150° F. Substantially Reduced Life at 150° F. to 250° F.
3. External Leakage Causes Fire and Safety Hazards When Temperature or Fluid Destroys Seals.

Miller Uses Leather Piston Cup Seals for Internal Sealing ... Standard Price (Teflon Cups Extra).

Piston Rings— As Dynamic Internal Seals

1. Most Piston Rings Allow Some Leakage.
2. Allow "Slip" or "Drift" of Piston Due To Leakage—Unsatisfactory for Many Applications.
3. Allow Varying Feed Rates Due To Leakage Because Of Viscosity Change During Startup—Unsatisfactory for Most Multiple and Automated Operations.
4. Allow Some Pressure Loss.
5. Chips and Dirt Enter Space Between Piston and Tube Causing Scoring —Especially During Startup.

All Teflon Sealed—*Another Miller "First"*

Miller - FLUID POWER DIVISION
PICK-READY CORPORATION

2008 N. Hawthorne Ave., Melrose Park, Ill.

AIR AND HYDRAULIC CYLINDERS • ACCUMULATORS
COUNTERBALANCE CYLINDERS • BOOSTERS

OTHER MILLER QUALITY FEATURES

- All Teflon Sealed Against External Leakage—Teflon Cups Extra
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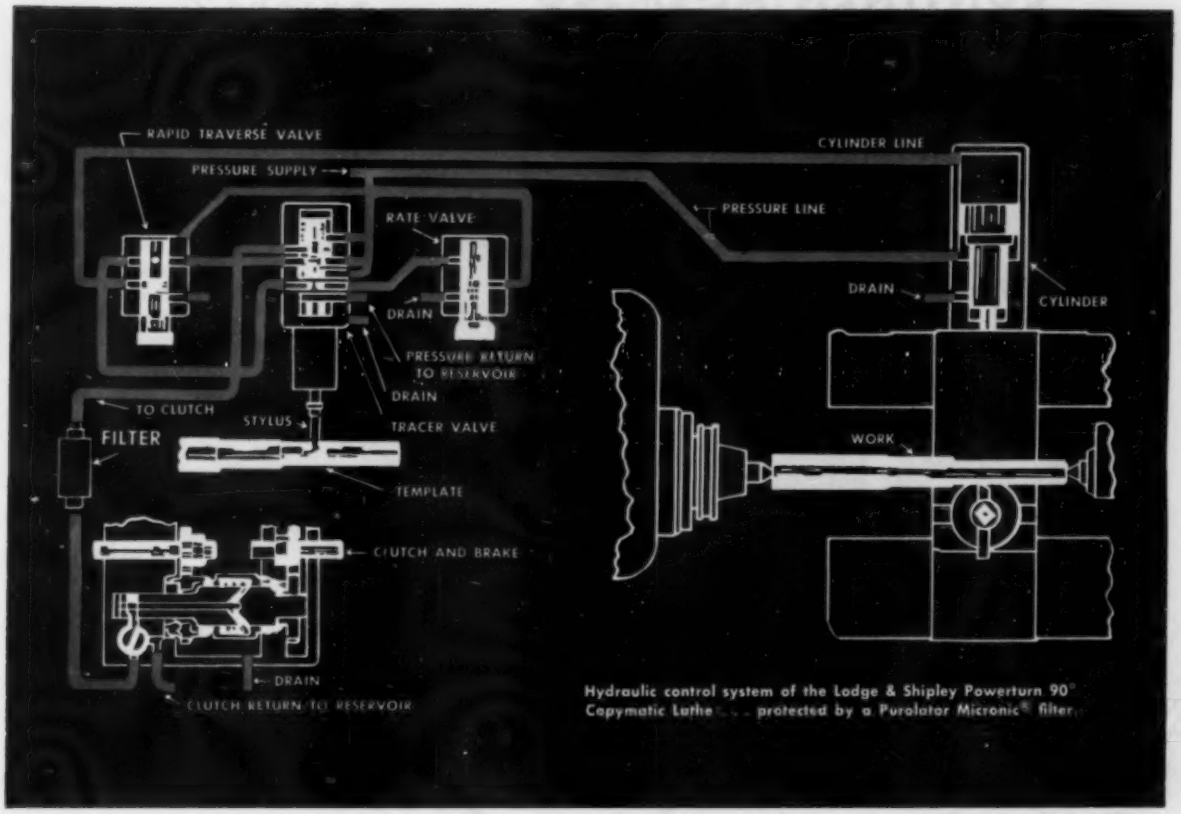
- Ball Check Interchangeable with Self Sealing and Locking Cushion Adjustment
- Rust Resistant Surfaces
- Teflon Oil and Dirt Wipers

Hydraulic Cylinder Tubing End Seal
PAT. APPLIED FOR



Hydraulic control system of the Lodge & Shipley Powerturn 90° Copymatic Lathe . . . protected by a Purolator Micronic® filter.

Designed for highly accurate control ...fully protected by Purolator Filtration

On a very successful automatic duplicating lathe, this hydraulic control system makes possible both quick, simple operation and a high degree of sensitivity and accuracy. Reliable and uninterrupted operation of a system like this is dependent upon freedom from contaminants. That's why the Lodge and Shipley Company, its manufacturer, made Purolator Micronic® filters an integral part of their hydraulic system.

Purolator engineers recommended a standard filter from their stock of over 2000 models. It more than met the system's special requirements.

The controlled porosity of Purolator's Micronic element evenly filters out contaminant particles as small as .000039 inch. And because it's made of plastic-impregnated cellulose, the Micronic element is not affected by high temperatures, water, or oil.

Filtering information for product designers is available in our 32 page "Filtration Manual for Product Designers". Just enclose 25¢ to cover postage and handling. Address Dept. P5

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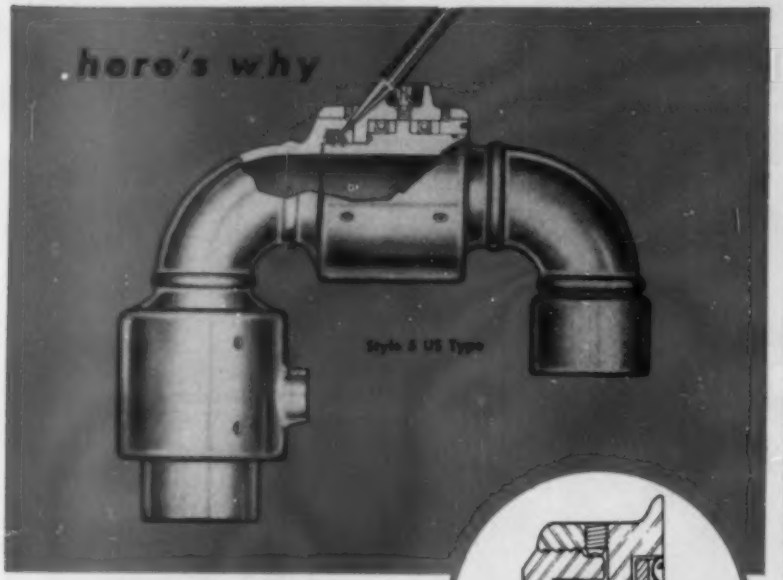
PRODUCTS, INC.

"FIRST IN THE FIELD OF FILTERING"

Rahway, New Jersey and Toronto, Ontario, Canada

Circle 84 on Reader Service Card

CONTINENTAL-EMSCO SWIVEL JOINTS LAST LONGER



GROOVED PACKING
Type US for high temperature or Corrosive Service.

UNIQUE DESIGN PERMITS EASY MAINTENANCE WHILE IN OPERATION

Three basic advantages of the Continental-Emsco Ball Bearing Swivel Joint are:

1. FREE TURNING
2. EFFICIENT PACK-OFF
3. LONG LASTING

A Continental-Emsco Swivel Joint is practically unexpendable for the reason that, after long service, both the packing and the ball races are easily adjustable and replaceable. This means no discarded joints—no costly return to the factory for repairs. Continental-Emsco "free turning" Ball Bearing Swivel Joints are manufactured for almost every type of service, from high vacuum to pressures of 15,000 psi, and from sub-zero temperatures to 750°F. Complete information, prices and delivery upon request.

Deformable packing extruded into annular grooves assures a positive seal. This Continental-Emsco patented method minimizes the effect on torque. Any packing material such as asbestos, Blue African Asbestos, or Teflon may be used in the US Type joint.

Joints using a lip type packing are available as Type HS or HP, depending on pressure involved.

LIP TYPE PACKING

CONTINENTAL-EMSCO

Serving the Oil and Gas Industries ... Worldwide

CONTINENTAL-EMSCO COMPANY
A Division of The Youngstown Sheet and Tube Company
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HOUSTON, TEXAS DALLAS, TEXAS CHICAGO, ILL.
Export Representative, E. J. Sisko & Associates, Inc.
10 Columbus Circle, New York 19, N.Y.

BRIEFS continued

198 pages; illustrated; Price 45 shillings.

This is the second of a series of textbooks published under the authority of the Royal Aeronautical Society to meet the needs of students and engineers in the aircraft hydraulics field. Volume 1, published previously, is concerned with general problems of hydraulic systems. This volume discusses design of the various system components. Volume 3, to be published soon, will cover landing gear design.

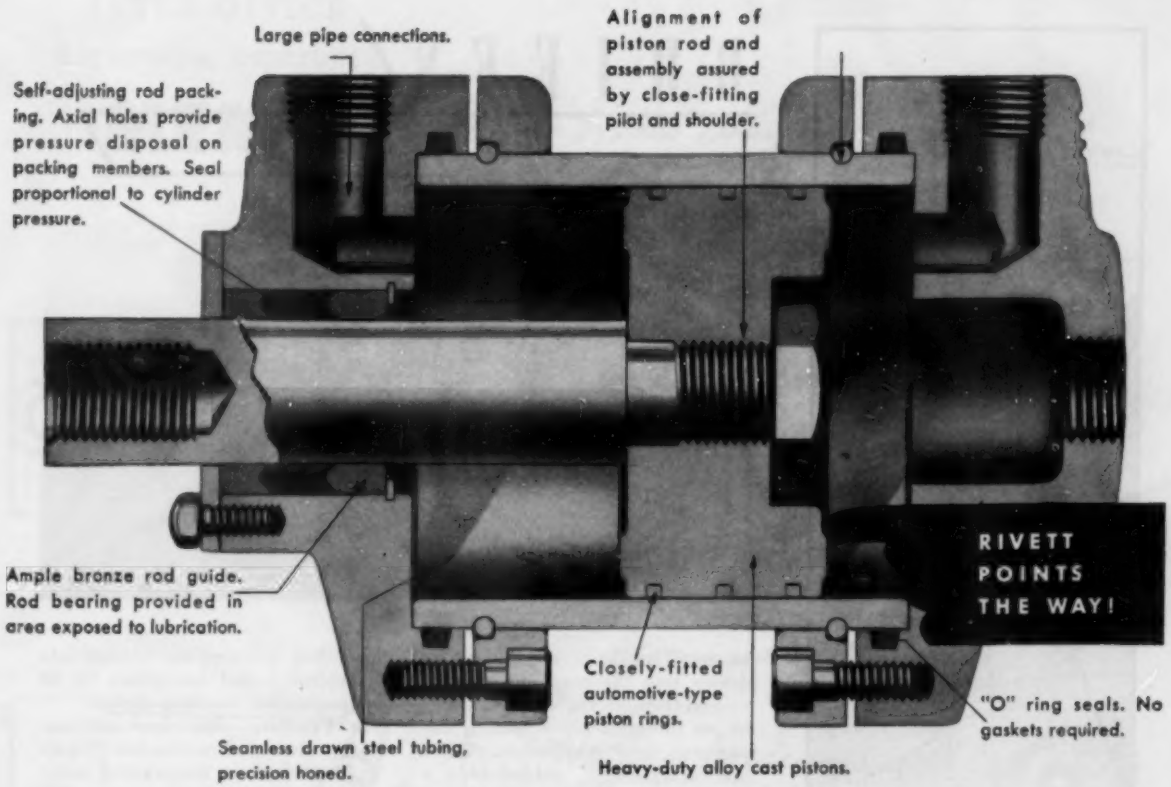
Chapters of this as well as the previous volume are written by authorities in the particular field involved. Well illustrated, the various chapters discuss seals, hydraulic pumps and motors, cylinders, selector valves, other valve types, piping, hydraulic servos and miscellaneous system components such as filters and accumulators. Many tables and charts are included. ▼▼▼

Four penetrating teeth extending in front of the blade enable the Caterpillar Tractor Co. Gyro-Dozer to rip and move hard material in one operation. To change the ripping angle of the teeth, the blade can be tipped forward or backward and tilted 20 degrees to either side. Two blade mounted hydraulic cylinders do the tilting. Two levers are located to the right of the operator which control blade positioning.

Air Power Automates Machine

Welding, trimming, cutting and forming operations to produce finished wire basket assemblies from bulk wire in a continuous operation, have been designed and built into this machine by Expert Automation Machine Co., Detroit,

Continued on page 40


Large pipe connections.
Alignment of piston rod and assembly assured by close-fitting pilot and shoulder.
Self-adjusting rod packing. Axial holes provide pressure disposal on packing members. Seal proportional to cylinder pressure.
RIVETT POINTS THE WAY!
Ample bronze rod guide. Rod bearing provided in area exposed to lubrication.
Closely-fitted automotive-type piston rings.
"O" ring seals. No gaskets required.
Seamless drawn steel tubing, precision honed.
Heavy-duty alloy cast pistons.

Sealing efficiency improves with increased pressure in Rivett 1500 PSI* Cylinders!

*Higher on application.

- External "O" Rings Act As Static Seals To Eliminate Gaskets And Assure LEAKPROOF OPERATION!
- Automotive Type Piston Rings Reduce Friction, Increase Sealing Ability, Permit Sensitive Response To Any Pressure.
- Keeper Ring Construction Eliminates Tie Rods.
- Self-Adjusting Rod Packing Cuts Friction.
- Unfailing Power For Millions Of Cycles.

1080 SELECTIONS!

7 mountings; 10 bores; standard and 2:1 over-size rod; single and double end rods; internal or external thread; cushioning either or both ends; special covers.

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Brighton 35, Boston, Mass.

Get Catalog No. 106 to aid your circuit design. Complete drawings, specifications, cut-away views, tables, diagrams!

Member National Fluid Power Association

THE BETTER YOU KNOW HYDRAULICS
THE BETTER YOU LIKE

RIVETT
"100"
HYDRAULIC CYLINDERS

On to Chicago...

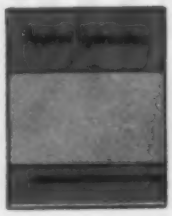
The October Issue of APPLIED HYDRAULICS will have complete, exclusive program coverage . . . with abstracts of papers . . . on the 13th Annual National Conference on Industrial Hydraulics being held October 17, 18, Hotel Sherman, Chicago. It will also feature articles winning the 3 Top Prize Awards in the 5th Annual Contest sponsored by APPLIED HYDRAULICS. Don't miss it.

OCTOBER ISSUE

Applied Hydraulics

Advertisers:

This special issue means heightened interest for your sales message. Forms close September 5th . . . regular space rates apply . . . order your advertising space today!



BRIEFS continued

Mich. Wire from stock coils is drawn into the machine and advanced through various operations by an intermittenly operated, air-powered feed mechanism. Wires are straightened, welded into a continuous strip pattern, and then notched, trimmed and formed into finished basket assemblies by an air-operated bending device.

• **Feeding**—The feed mechanism consists of mechanical fingers mounted on an air-powered index

Continued on page 42

BRIEF NOTES

PRESSURE VESSELS . . . of high strength titanium alloy for aircraft, missiles, and industry were unveiled by Titanium Fabricators Inc., Burbank, Calif. Using new developments in quenching and heat treating, the new "bottle" forming system is much cheaper than previous methods.

NEWS LETTER . . . containing technical articles on new fluid power components, controls and systems will be periodically published by Oilgear, Milwaukee. "Oilgear Fluid Power News" will also contain illustrations and features on unique applications plus company and personnel news.

NYLON PIPE JOINTS . . . for use to 3000 psi have been under test to replace the copper diamond joint currently fitted in naval hydraulic systems using OM. 13 (light mineral oil). Admiralty Engineering Laboratory, West Drayton, England tested various forms of steel rings enclosing rubber joints before they settled for nylon rings.

WINNERS . . . of a national sales contest sponsored by Titeflex, Inc. Springfield, Mass. Inc. have been announced. Irving S. Rosenberg won top honors for his description of Monsanto's use of Titeflex couplings. More than 125 entries were received from Titeflex sales reps in 30 states.

BUSINESS BRIEFS

RECORD SALES . . . of $20,928,660 for a six month period ending Mar. 31, 1957 were recorded by Aeroquip Corp., Jackson, Mich. This is 35% above the comparable period of fiscal 1956. Net earnings for the fiscal year should pass the $2,000,000 mark.

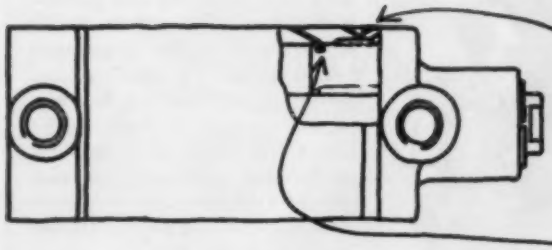
MERGER . . . of Simplex Engineering Co, and Racine Hydraulics & Machinery, Inc. was announced shortly before Racine closed its fiscal year with record sales of over 5 million dollars. The acquisition couples Racine's medium-pressure lines with the high-pressure equipment of Simplex. Basic operations will continue unchanged by both companies.

INTER-OFFICE

Engineering Department

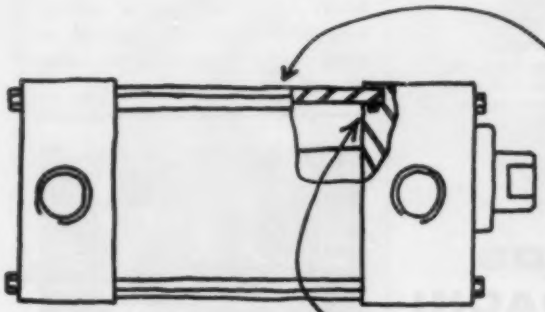
MEMO

Jim - Here's why I think Pathon Hydraulic Cylinders fit our long stroke applications better.



Pathon head is attached by a single screw thread.

Head seal is a true static seal - will give us much longer life.



Higher pressures will stretch the tie-rods on this cylinder - heads will move relative to the tube

This makes head seal dynamic - subject to wear and subsequent trouble

NOTE THIS JIM: Pathon Cylinders fit the bill in shock loads too. We can use the greater strength that Pathon single screw thread attaching method provides.

Tell purchasing to write

PATHON MANUFACTURING CO.
3823 PACIFIC AVE.
CINCINNATI 12, OHIO

ask for catalog #22-A

Ψ could designate P. S. I. - 101

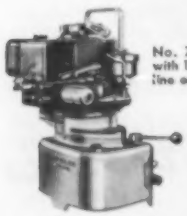
Up to 10,000 psi,
6,000 psi continuous

No. 798-AC Power Pump with ¾-hp, 115-230-volt a-c electric motor

TWO SPEEDS FOR FAST RAM APPROACH!

GREENLEE NO. 798 Portable Power Pumps eliminate nearly all the time loss accumulating while operators of hydraulic devices wait for the ram to contact the work! If you specify pumps for hydraulic rams, jacks, presses, or other systems, be sure to learn the details of this *exclusive* advantage and numerous other advance features of GREENLEE No. 798 Power Pumps capable of developing continuous pressure of 6,000 psi and up to 10,000 psi intermittent pressure. Delivery rate at 1,000 psi, 36 cubic inches per minute; at 10,000 psi, 28 cubic inches. Available with 115-230-volt a-c or 115-volt ac-dc motor; also with gasoline engine. All deliver fast dependable hydraulic power with superior efficiency.

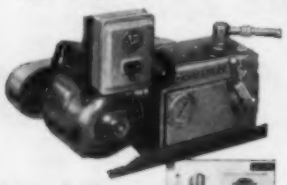
Fast hydraulic return of ram is available in every type GREENLEE Power Pump! All pumps available for *either* single-action or two-way-action rams.



No. 798-GM—with 1.7-hp gasoline engine

No. 798-CO—with ½-hp, 115-volt ac-dc universal electric motor

No. 797-E—with choice of 2-hp or 3-hp a-c electric motor, delivering 106 or 213 cu in. of oil per min. Also available with gasoline engine.



TOOLS FOR CRAFTSMEN
GREENLEE

WRITE, or simply attach this page to your letterhead, for illustrated data sheets giving applications, features, and specifications of GREENLEE No. 798 Pumps.

GREENLEE TOOL CO., 2448 HERBERT AVE., ROCKFORD, ILLINOIS, U.S.A.

BRIEFS continued

slide. The fingers engage the welded cross wires from below.

• **Transfer**—An air-powered transfer mechanism carries the cut pattern length into a forming station where the two hanger sections are formed in the flat wire pattern.

• **Folding**—The pattern length is advanced to the air-powered folding fixture. The double-jointed folding arms form the flat wire pattern into a finished rectangular basket. The two folding arms are air-operated, and each arm consists of a primary and secondary actuating lever. With the pattern length and tie wires in proper location, an air cylinder is actuated which pivots both primary levers. After welding, a curling tool is automatically applied to complete the bending of the hanger section. ▼▼▼

The heat-treated 4130 steel body for an aircraft hydraulic accumulator receives precision contour machining on a Monarch Machine Tool Company 16 inch manufacturing lathe equipped with an air-gauge tracer automatic cycle unit. The automatic cycle unit makes possible a total machining time of only 2.2 minutes per piece.

Power Steering Hose Tester

A machine for simulating actual road conditions has been developed to test power steering hose. The apparatus consists of three principle parts; an insulated test chamber, a circulating oil system, and a refrigeration source. The test chamber contains inlet and outlet manifolds arranged with

Continued on page 44

Naugatuck PARACRIL

The oil-resistant nitrile rubber

"...the rubber we know will resist 'em all!"

"We can't be sure just what kind of oil or other hydraulic fluid will be in contact with our hydraulic hose liners, pressure seals and accumulator bladders, so we use the rubber we know will resist 'em all!" That was the reply when one manufacturer of rubber products was asked about his choice of PARACRIL® for rubber hydraulic specialties.

"In addition, PARACRIL gives us the low-temperature flexibility and other properties needed to meet government specs. The broad range of PARACRIL types enables us to achieve, at low cost, almost any combination of oil resistance and required physicals. We also use PARACRIL for lining our gasoline, fuel oil and liquid petroleum gas hose because of its superior resistance to aromatic hydrocarbons."

Whenever softening or swelling of rubber in contact with oil may decrease efficiency or shorten service life, designers and users alike will do well to specify PARACRIL. Extensive literature on PARACRIL nitrile rubber is now available. Write us the exact nature of your interest in oil- and grease-resistant rubber and we'll gladly send you, without cost, the pertinent technical bulletins.

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

IN CANADA: NAUGATUCK CHEMICALS DIVISION • Dominion Rubber Company, Limited, Elmira, Ontario • Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

US RUBBER

YOUR CYLINDER ORDER SHIPPED IN 24 HOURS OR LESS!

— LET CARTER CARRY YOUR INVENTORY!

ANY BORE SIZE
ANY MOUNT
ANY STROKE

AIR OR HYDRAULIC

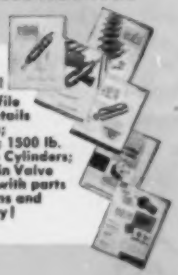
CARTER
CYLINDERS

Get your cylinders *now*, when you need them. No need to lose production because of poor delivery! Carter will *ship your cylinder order in 24 hours or less*, to satisfy your needs. And when you buy Carter cylinders, you buy quality—rugged, dependable cylinders.

Leakproof construction . . . strong key-type locking of body between tubing and heads . . . compact, space-saving design. Everything you need in a cylinder . . . *plus special delivery to you.* Get in touch with us *today* for what you need *tomorrow!*

PHONE SERVICE
24 HOURS A DAY!
Order day or night. For fast service call CARTER: LANSING, ILLINOIS. GRanite 4-3305 or CHICAGO, BAyport 1-7186. TELETYPE LNSG, ILL 1119X.

COMPLETE CATALOG FILE!
Complete bound file with ordering details for: Air Cylinders; 750 lb. Hydraulic; 1500 lb. Hydraulic; Clamp Cylinders; Air Valves; Built-in Valve Types. Complete with parts data, specifications and prices. Send today!



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2972 Bernice Road • Lansing, Illinois (Chicago Suburb)
AIR CYLINDERS • AIR VALVES • HYDRAULIC CYLINDERS
ROTARY ACTUATORS • SPECIAL CONTROLS

BRIEFS continued

multiple connections for simultaneously testing a dozen hoses. The circulating oil system has a heated oil reservoir, a positive displacement pump, and a pressure pulsating mechanism.

• **Pressure Pulsation**—A solenoid valve, in the return line from the outlet manifold, is controlled by a rotor and cam operated contact switch. The pressure

regulating valve is installed just ahead of the inlet manifold and maintains the system at either 100 or 900 psi as the solenoid valve alternately cycles open and closed.

• **24 hour cycle**—The hot cycle (when the oil is circulating) lasts 19½ hours. The test chamber is then cooled to room temperature for 1½ hours. The cover is then reinstalled on the test chamber and cold air is blown over the tubing for the remaining 3 hours. The tester was developed by the Chrysler Corp., Detroit. ▼▼▼

Self-Locking Fasteners Seal Hydraulic Fluids

Self-locking bolts were designed primarily to eliminate lock washers and other locking devices. However, through actual usage, it was found that they tended to resist liquid leakage. These fasteners have a nylon pellet embedded in them. The pellet projects slightly beyond the thread, creating strong metal-to-metal contact when installed. The Nylok Corp., Elmira Heights, N.Y. devised a number of tests to determine how the fastener would seal under specific conditions.

• **The Tests**—A test fixture was machined from close-grained cast

Continued on page 46

ATHEY PRODUCTS builds rugged, hard-working rear dump trailers..

DENISON
hydraulic pumps give the power punch

Rear dump trailer manufactured by Athey Products Corp., Chicago, Ill., incorporates 3-stage hydraulic rams to dump the load . . . with power provided by a Denison 2000 psi hydraulic pump.

They're rugged workers . . . these rear dump trailers manufactured by Athey Products Corporation. They're built to take the toughest punishment of today's high-speed hauling and earth-dumping jobs. To insure dependability, they're powered by Denison hydraulic equipment.

Capable of carrying loads up to 34 tons, Athey rear dump trailers incorporate powerful 3-stage hydraulic hoists which tilt the body as much as 60° to dump the contents quickly.

Athey selected a Denison 2000 psi balanced vane hydraulic pump to furnish the power for the hydraulic system. As so many manufacturers of construction equipment have found, Denison hydraulic pumps provide the ultimate in power efficiency . . . require minimum maintenance . . . last longer.

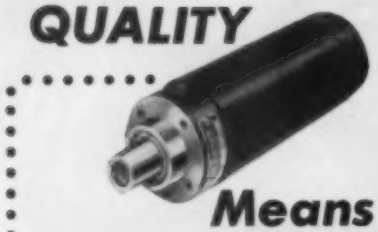
Look for the Denison name on hydraulic components in your construction equipment. It's your assurance of highest quality and dependability. Denison Engineering Division, American Brake Shoe Co., 1166 Dublin Rd., Columbus 16, Ohio.

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

Your guide to better performance in construction equipment

DENISON HydrOILics

O-M Built-in QUALITY



Means Built-in ECONOMY

O-M Tie-Rodless Cylinders
150 PSI Air—Up to 1500 PSI Oil
Meet JIC Standards
Fit Where Others Won't

O-M cylinders were designed with both the "Original Equipment Manufacturer" and the "User" in mind.

Space-Saving – O-M is the original compact "Fits where others won't" cylinder, allowing smaller castings to be used in machines, or "More power for same space"—easily oriented ports – aids in design problems.

Best of Materials – Precision honed steel barrels, bronze bearing surfaces, machined steel end covers, highly polished chromed piston rods, rod scrapers, proper packings for the various operating mediums and pressures – just to mention a few.

Long Life – Quality material, accurate machining, fine finished, proper bearing materials, precision assembly, individual testing are assurances of long life.

Easy Maintenance – The internal key feature not only makes it possible to save space and to easily orient ports, but also makes it easy to disassemble, inspect, clean, repair and reassemble – thus further reducing costly downtime.

Original Cost – Priced right! Compare prices and quality to be convinced.

O-M Air and Hydraulic Tie-rodless Cylinders are available in a complete range of sizes (1 ½" to 8" bores) with standard or heavy duty rods. Completely interchangeable parts and mounts. Immediate delivery on many sizes.

Mail coupon at once for Bulletins 101A (O-M Tie-Rodless Air and Hydraulic Cylinders) and 105 (O-M Series T-H — Heavy duty Hydraulic Cylinders)

ORTMAN-MILLER MACHINE CO.
1 143rd Street, Hammond, Indiana

☐ Have representative call
☐ Send Bulletins 101A and 105

Name_____ Position_____
Company_____
Address_____
City_____ Zone____ State_____

BRIEFS continued

iron and tapped with a Class 2B thread. A tiny bleed hole was drilled into the counterbore at the entrance to the tapped hole between the seating surface and where the nylon pellet would be when the bolt was seated. This was done to eliminate any sealing that seating the head would produce. The bolt was then screwed into the fixture and seated to 50 ft-lb torque. A pressure of 5000 psi was applied to the bolt for 48 hours. No leakage occurred. Since the bleed hole in the side of the fixture bypassed the bolt head, seating the head had no effect on controlling leakage.

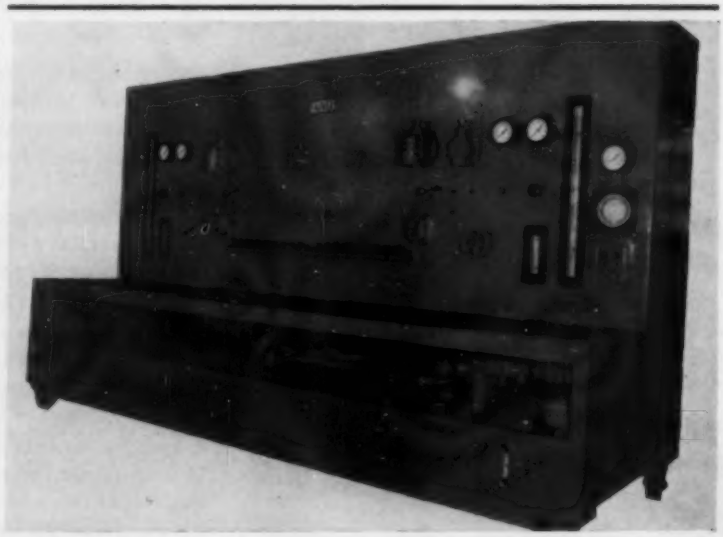
To test if the nylon pellet would break down with continued exposure to certain common liquids, the fasteners were subjected to 120-day immersion tests in a variety of media. Some of the fluids used in the tests were: hydraulic fluid, jet-engine lubricating oil,

Skydrol, and fluids meeting military specs MIL-O-5606, and MIL-F-7083. The tests revealed that the metal fasteners were attacked in some cases, but the nylon pellet was impervious to attack. ▼▼▼

Dual Hydraulic Pump Lifts 20,000 Pounds

Use of fluid powered equipment on a new series of lift trucks resulted in greater maneuverability and faster lifting speeds. Lift-tilt cylinders are fitted with anticavita-

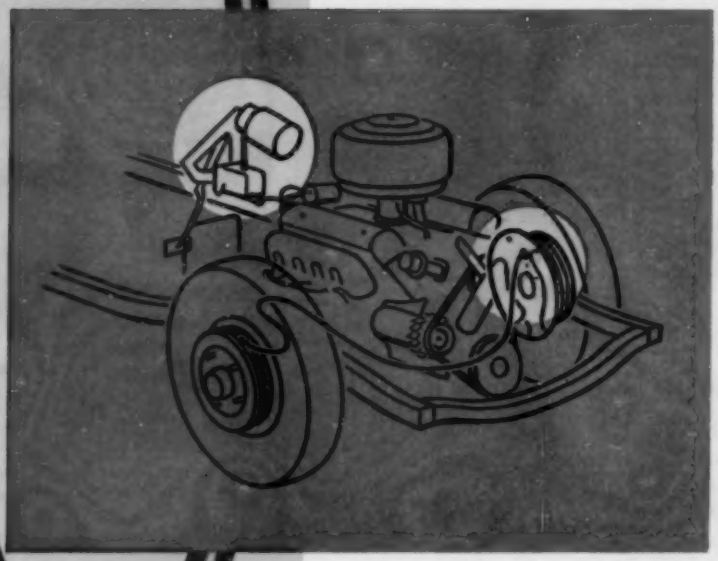
Continued on page 48



For testing hydraulic cylinders up to 10,000 psi at the Miller Fluid Power Division of Flick-Reedy Corp., the Hydraulic Div. of J. N. Fauver Co., built this test stand. Hydraulic pumps supply fast traverse volume to several test cylinders and large boosters raise the pressure up to 10,000 psi at the end of the stroke. With the timer arrangement several cylinders can be cycled continuously. Manometers are provided to check packing leakage. Air pressure for these tests is controlled by manually operated valves. Quick disconnect couplers and hoses connect cylinders to the stand. A 300 gallon reservoir is built in the bottom of the test stand.

...for greater safety...LONGER

LINEAR KEEPS THE POWER IN POWER BRAKES
with Roto-Mold "O" Rings



Power brake systems, that stop two tons of automobile with pedal pressures too light to crack an egg shell, require lasting seals of uniform physicals and dimensions—seals that will withstand actuating fluid pressures... mechanical wear... abuse... chemical action of brake fluids and destructive action of improper hydraulic mediums.

LINEAR'S ability to produce precision "O" rings in the most modern elastomers has helped solve a wide variety of sealing problems involving extreme ranges of temperatures (from −130° to 450° F), operating pressures up to 50,000 psi, and the corrosive action of silicate or phosphate esters, hydrocarbon or petroleum base fluids, or synthetic lubricants.

The exclusive Roto-Mold process assures top quality production ... maximum economy... fast delivery schedules.

When it's a sealing problem, call on LINEAR or one of its agents for engineering assistance...
and be sure to specify LINEAR Roto-Mold "O" Rings.

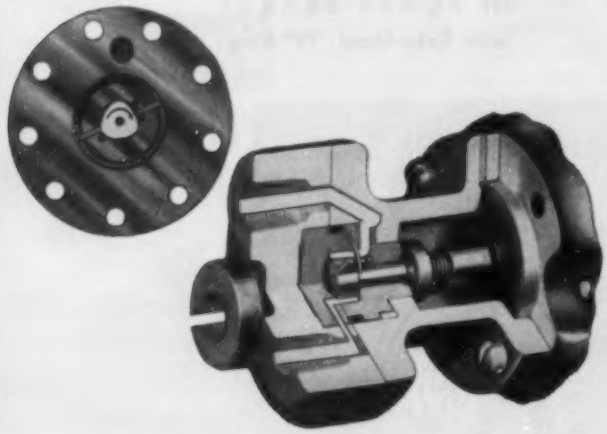
"PERFECTION IN RUBBER"
LINEAR
LINEAR, Inc., STATE ROAD & LEVICK ST., PHILA. 35, PA.

Circle 66 on Reader Service Card

WELDON

FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.

Compact • Light Weight

Send for Weldon Manual and Catalog with detailed specifications and installation drawings, covering the full range of Weldon pumps in various capacities. Specify your requirements.

THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO

BRIEFS continued

tion valves that prevent hydraulic pressure voids thus eliminating channel drift. Built by Yale and Towne Mfg. Co., Philadelphia, the truck has a low center of gravity, high underclearance, vacuum pow-

ered hydraulic brakes, and power steering. Steering assembly utilizes two hydraulic cylinders, one to each steer wheel. The hydraulic pumps are located in a protected position in front of the counterweight. A compartment below the operator houses the control valves and linkage. ▼▼▼

Air-Oil Cylinder Tests Slings

To detect and eliminate weakened rope slings before they fail, engineers at Calumet & Hecla's Wolverine Tube Div., Detroit, designed and built a simple, rugged, mobile rope tester out of spare parts. They use about 5000 rope slings to handle unit loads of tubes in process.

• **Construction**—An 8-in. ID air-hydraulic cylinder with a 15-in. stroke provides the force for testing the slings. The cylinder is bolted to the frame, and a hook is mounted on the cylinder piston. The cylinder hook runs in a groove so that it does not twist as the rope is put under tensile load. A hook is mounted at the opposite end of the frame. Air at 80 psi is supplied to the unit and a pressure-regulated valve steps it down and maintains a pressure of 38-40 psi to the cylinder. ▼▼▼

Circle 123 on Reader Service Card

Circle 101 →

the hydraulic oil you are using against these properties of STANOIL *Industrial Oil*

1 *Stability*

Special solvent-refining techniques and the addition of an exceptionally effective antioxidant give STANOIL Industrial Oil unusual resistance to chemical change.

2 *Good Pour*

Oil has got to flow to the pump. STANOIL's low pour point results from selective refining to remove wax. Special additives further lower pour point. STANOIL flows freely from a cold start. System never fails because oil doesn't flow.

3 *Ability to release air*

All mineral oils absorb air. Oil in a hydraulic system is especially susceptible to absorption of air. Effective release of air depends much on the degree of refining. Superior refining techniques used in manufacture of STANOIL assure ready release of air. A special antifoam agent further depresses any foam tendencies in STANOIL.

4 *Viscosity*

If oil viscosity varies, there's trouble. Oil too thin means excessive slippage or poor oil flow. The pump won't deliver power and there may be excessive wear. Oil too heavy means excessive fluid friction, power loss and sluggish operation. STANOIL has a high viscosity index, is extremely resistant to viscosity change at high or low temperatures, operates just as effectively at start as at full operating temperature.

5 *Rust protection*

Hydraulic system rust can't be tolerated. Rust scratches valve parts, pistons and other system parts. Rust particles can hold valves open or close off small openings. STANOIL Industrial Oil contains an advanced type of corrosion inhibitor. Inhibitor plates out on metal surfaces, effectively protecting all parts of system.

Get all the facts about STANOIL Industrial Oil from the Standard Oil industrial lubrication specialist nearest you in any of the 15 Midwest and Rocky Mountain states. Or write Standard Oil Company, 910 So. Michigan Avenue, Chicago 80, Illinois.

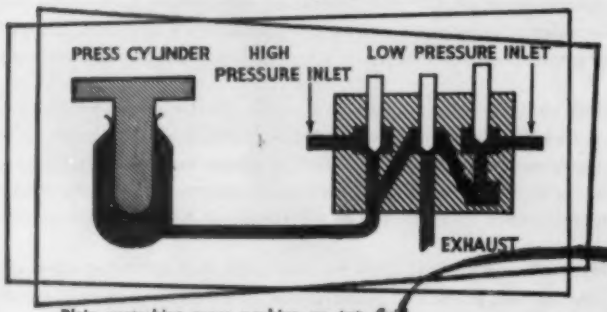
STANDARD

STANDARD OIL COMPANY
(Indiana)

AUTOMATION at low cost

For users of hydraulic power, an effective form of Automation is readily available by the simple installation of Ellison air operated valves and a suitable timing instrument. Such an installation costs very little in capital outlay but enables several hydraulically operated machines to be controlled automatically by a single operator. The uses for Ellison valves with timers are varied and numerous. One important advantage is the [illegible] safety devices as, for example, automatic control of machine guards to comply with Factory Act regulati[illegible].

Send for full details



Plain upstroking press working on two flui[illegible] pressures with gravity return of ram.

Made by

GEORGE ELLISON
LIMITED

PERRY BARR BIRMINGHAM 22B
ENGLAND

SM/GE 2778/2

how ASCO solenoid valve compactness solves SILEX control problems

Is limited space a problem in your design? ASCO 2-Way Bulletin 8210A Solenoid Valves can save you critical space—just as they have in the compactly designed "Silex Coffee Maker." Here three ASCO valves were crammed into an extremely limited area: a drain valve which flows hot water into the brew tank; a decanter valve which channels brewed coffee to the dispenser and the 8210A which releases cold water to flush out coffee grounds. The 8210A valve used measured only 3 13/16" in height; 2¾" face to face.

Here is what Silex Project Engineer, H. M. Voglesonger, had to say about the 8210A: "The compactness of the ASCO line of solenoid valves makes them ideal for the close quarters required in the internal construction of our Silex Coffee Brewers. The 8210A valve and the two specially designed valves we have selected have proved extremely reliable; after a year of operation under the most severe conditions, we were thoroughly satisfied with the product quality. ASCO 'Engineering Service'—the extra help provided by the ASCO Engineering Staff – made the successful manufacture of the equipment possible."

Bulletin 8210A valves are available in pipe sizes up to 3"; pressures to 350 p.s.i.– in standard, watertight or explosion proof enclosures. Fluids handled include air, gas, water, light oil and other non-corrosive liquids or gases. If you have a flow control problem involving any fluid—corrosive or non-corrosive—check on the advantages of these ASCO qualities: compact design, dependability in action and cooperative "Engineering Service." Write for complete details.

Write for Catalog 201 covering complete line of ASCO solenoid valves

See us at The ISA. Show Sept. 9-13—Booth #931

Automatic Switch Co.
50-B Hanover Road, Florham Park, New Jersey
FRontier 7-4600

ASCO

Useful Literature

For your free copy of publications reviewed, fill in the reader service card

MANIFOLD CATALOG . . . containing 20 pages of complete dimensional drawings is available from Birmingham Hydraulic Products, Detroit. There is also a how-to-order section, and an explanation of valve subplate code numbers. A cross-reference sheet for valve subplates, and a complete price list and discount sheet are featured in the catalog.

Circle 140 on Reader Service Card

COUNTERBALANCE VALVES . . . manufactured by Fluid Controls, Inc., Mentor, Ohio, are discussed on Sheet No. 2.50. JIC sketch shows common use of counterbalance valve, and its operation is shown in a schematic diagram.

Circle 141 on Reader Service Card

FILTERS . . . for aircraft and missiles are illustrated and discussed in catalog 54-100 from Cuno Engineering Corp., Meriden, Conn. Described are: micro-mechanical filters, housings, cartridges and micro-magnetic filters. The features of Poro-Klean sintered material are also described, including heat resistance, tensile strength and corrosion resistance.

Circle 142 on Reader Service Card

COUPLINGS . . . and hose accessories are the subject of Catalog 100, Eastman Mfg. Co., Manitowoc, Wis. The catalog is divided into four sections: one, two and three wire-braid hose and assemblies, fabric-braid hose, and spiral-wire hose. Clamp couplings are described and illustrated in Eastman bulletin 40. Bulletin 105 A covers two-piece reusable couplings and bulletin 500 illustrates adapter unions, adapters, and tube fittings. The catalog and bulletins are loose-leaf style, and can be bound together. In addition to the company's products, many helpful hints such as how to properly install hose-are included.

Circle 143 on Reader Service Card

AUTOMATIC RING PACKING . . . developed by Johns-Manville, New York, N. Y., for hydraulic and pneumatic applications, is discussed in Bulletin PK-58A. Design and features of this type of packing are illustrated and described and a chart gives recommended design standards.

Circle 144 on Reader Service Card

HYDRAULIC RELAY . . . for web guiding, registering flow, pressure, and control of manufacturing operations is covered by bulletin 1-001 from North American Mfg. Co., Cleveland. The bulletin features actual performance curves, component part and cut-through photos and dimensional drawings.

Circle 145 on Reader Service Card

VALVES & CYLINDERS . . . are described and illustrated in Bulletin SW-3 from Galland-Henning, Milwaukee. Cutaway drawings, photos, and dimensional drawings are included, with convenient mounting charts. Master, single, and double-solenoid valves; and hand and foot-operated valves are individually featured.

Circle 146 on Reader Service Card

TRANSDUCERS . . . for measurement of forces and pressures in fluid power applications, are manufactured by Kistler Instrument Co., North Tonawanda, N. Y. Available bulletins give details and engineering information on models covering pressure ranges of zero to 30,000 psi, and withstanding intermittent temperatures above 3000 F. Units feature small size, fast response and high sensitivity.

Circle 147 on Reader Service Card

LIMIT SWITCHES . . . for every fluid power control requirement are produced by Micro Switch, Div. of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Bulletin shows units for various applications, including basic switches for controlling and sensing motion and interlocking circuits; rotary selectors for maintained or momentary detents; pushbuttons; toggles; and door interlocks.

Circle 148 on Reader Service Card

FLOW METERS . . . are the subject of Bulletin 110, Brooks Rotameter Co., Lansdale, Pa. A novel method is employed to select the right meter for a specific application. A rotating disc indicates the pressure and temperature limitations and flow capacity ranges. A brief description of each meter is given, with references to further detailed literature.

Circle 149 on Reader Service Card

PUMP GENERATORS . . . are described with cutaway and dimensional drawings in Bulletin 100-P1, Commercial Shearing & Stamping Co., Youngstown. Also included are motor converters, valve controls, and cylinder converters.

Circle 150 on Reader Service Card

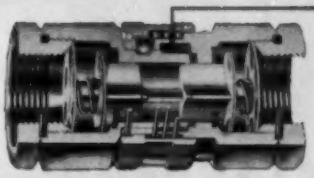
Continued on page 54

WHICH SNAP-TITE QUICK-CONNECT COUPLING IS BEST FOR YOU?

SNAP-TITE "H" COUPLING . . . . . FOR HIGH PRESSURE APPLICATIONS

FOR HYDRAULIC OR AIR

"H" Coupling for high strength, higher efficiency, high-resistance to heavy line surge. Sizes: ⅛" thru 12". Bulletin No. 240

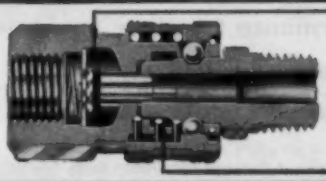


Exclusive U-packer gives a positive seal without compression set because of rubber distortion. Line pressure inside the U-packer keeps it open and forced against its metal backing—the higher the pressure, the tighter the seal.

SNAP-TITE HI-FLOW COUPLING . . . FOR LOW PRESSURE APPLICATIONS

FOR AIR AND FLUIDS UP TO 150 p.s.i.

Hi-Flow is recommended to connect small air tools to plant air system, and for low pressure fluid transfer in small lines.
Sizes: ⅛" thru ¾". Bulletin No. 230

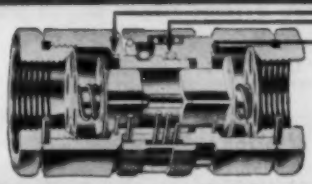


Bonded valve washer
(pat. pending on valve construction)

Exclusive U-packer

SNAP-TITE "HK" COUPLING . . . . . FOR HARD TO HANDLE FLUIDS

FOR FUMING ACIDS, ALKALIES, SOLVENTS, AND HIGH PRESSURE STEAM . . . "HK" is the only coupling now on the market for fluid temperatures from —100° F to +500° F . . . and for live steam up to 460° F. Its seals are made of Teflon for which there is no known solvent.
Sizes: ½" thru 3". Bulletin No. 270



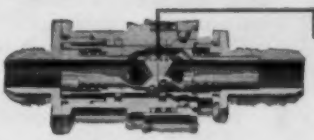
Teflon Valve Seal

Teflon Nipple Seal

Teflon Valve Seal

SNAP-TITE NO-SPILL COUPLING . . . FOR MINIMUM AIR INCLUSION

FOR AIRCRAFT, MISSILE HYDRAULIC, FUEL SYSTEMS which cannot stand air in the lines, and for transmitting fluids which *must not spill*, the Snap-Tite no-spill coupling is recommended.
Bulletin No. 280

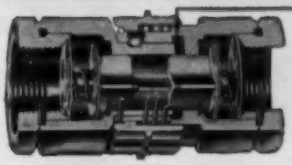


Flush valves prevent spillage, air inclusion. Snap-Tite will engineer special variations to your requirements.

SNAP-TITE "E" COUPLING . . . . . FOR VACUUM and VERY LOW PRESSURE

FOR VACUUM SYSTEMS IN THE MICRON RANGE

"E" Coupling performs in the *micron* range in the smaller sizes both connected and disconnected. Recommended, too, for gravity flow . . . U.L. approved for LP Gas.
Sizes: ⅛" thru 12". Bulletin No. 250



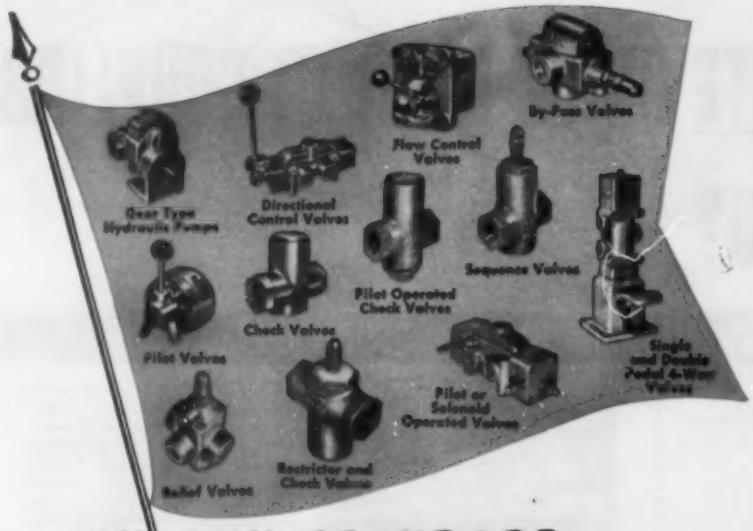
Nipple seals in coupler by depressing the lip of the E packer and slightly compressing the body of the packer. This new E-packer gives positive seal under high-pressure, low-pressure, and vacuum.

Snap-Tite Couplings are available plain, (without valves), and with either single or double shut-off. Couplings normally furnished in alloy steel, but all (except hi-flow) are also available in brass, aluminum, or stainless steel with a variety of finishes.

SNAP-TITE, INC., UNION CITY 1, PA.

Snap-Tite

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS



BY ANY STANDARD...

ADEL *Refinements* assure Plus Performance for Your Equipment

Designers and Engineers have set these standards for Industrial Hydraulic Equipment

Rugged simplicity • Long life • Simplification of piping • Reduced installation costs • Greater accessibility for maintenance • Completeness of line • Over-all economy

ADEL brings them all to you!

Smooth economical hydraulic power for Pushing, Pulling, Lifting, Pressing, Clamping and Controlling.

Illustrated are but a few of a wide variety of ADEL industrial hydraulic control equipment that offer definite benefits to both the user and builder of machine tools and many other kinds of equipment. ADEL products incorporate proven design and precision construction features that assure dependable operating efficiency over the years. A complete line for every application. You can simplify your Hydraulic Power Motion Problems by specifying ADEL.

For complete engineering specifications and counsel, Address: ADEL PRECISION PRODUCTS, 10771 Van Owen Street, Burbank, California

Reliability

ADEL PRECISION PRODUCTS

A DIVISION OF GENERAL METALS CORPORATION

BURBANK, CALIFORNIA • HUNTINGTON, WEST VIRGINIA

Manufacturers of MARINE & INDUSTRIAL HYDRAULIC CONTROL EQUIPMENT

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TEXAS •
Air-Draulic Equipment Company
Houston, Texas

UTAH •
Robert Taylor & Sons
Salt Lake City 10, Utah

WASHINGTON •
Haskel Engineering & Supply Co.
Seattle, Washington

Useful Literature / continued

SOLENOID VALVES . . . are the subject of Catalog D2, Skinner Electric Valve Div., Skinner Chuck Co., New Britain, Conn. Stock numbers and coil types are explained; 2, 3, and 4-way valves with pressures to 1000 psi are pictured and described. Included are ordering tables and dimensional drawings.

Circle 151 on Reader Service Card

HEAVY-DUTY CYLINDERS . . . and hydraulic control valves are covered by sections 6 and 7 of catalog 200 issued by Logansport Machine Co., Logansport, Ind. Section 6 lists cylinders in bore sizes from 1½ to 8-in. and pressures to 2000 psi. There are dimensional drawings, charts, tables, and illustrations showing the 15 mounting styles, stroke, and cylinder sizes. Section 7 lists over 40 control valves, including 2 and 3-position single and double-solenoid models.

Circle 152 on Reader Service Card

TITANIUM PIPE BULLETIN . . . contains data on sizes and tolerances, physical properties, fabrication, and corrosion properties tables. This seamless tubing is for use in severe corrosive environments. Bulletin TDC-185 is published by Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

Circle 153 on Reader Service Card

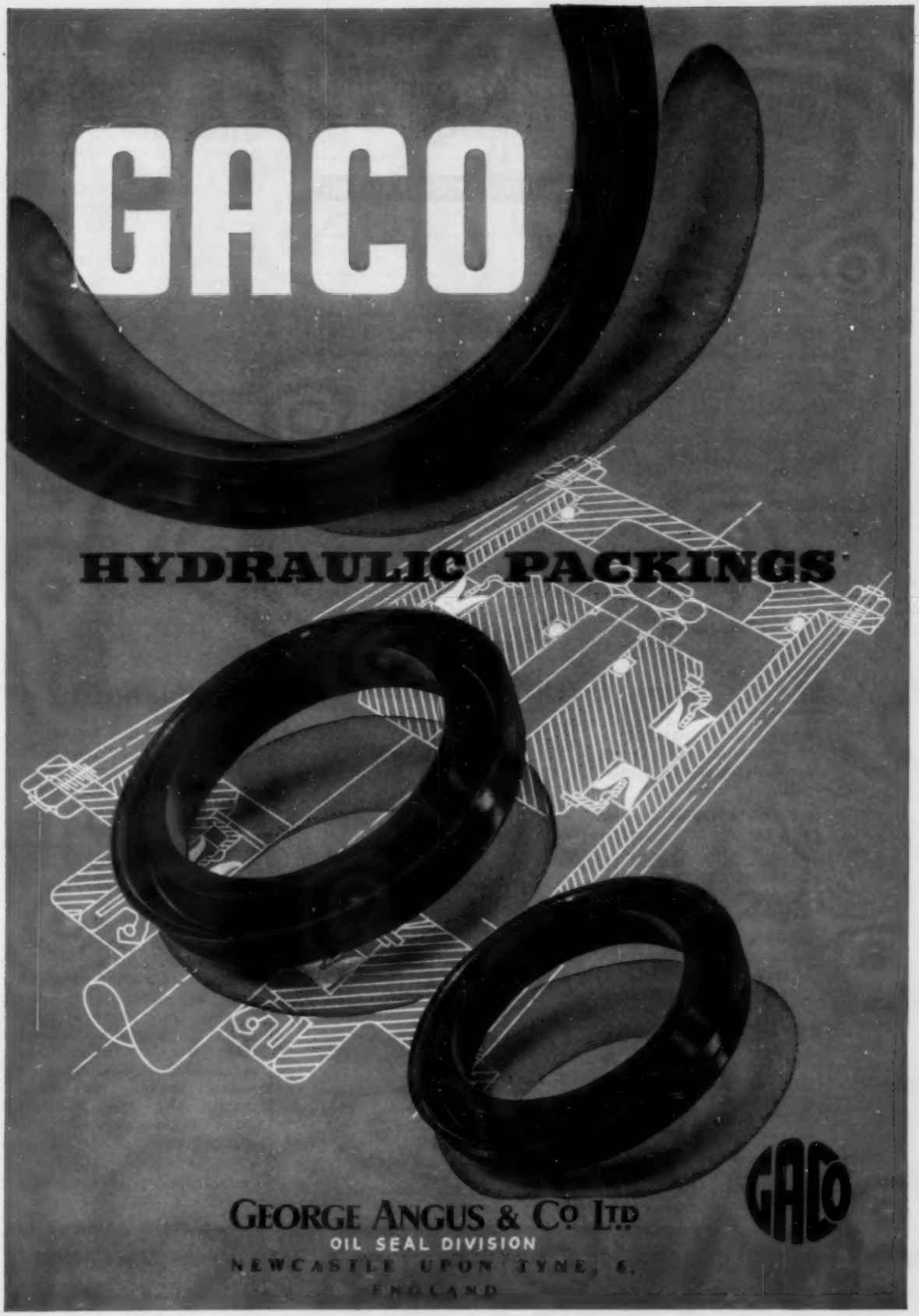
DIAPHRAGM VALVES . . . of several types are illustrated in bulletin V-8, Seely Instrument Co., Niagara Falls. Included are cutaway drawings of direct-acting, reverse-acting, and three-way valves. Dimensions and pressure data are included.

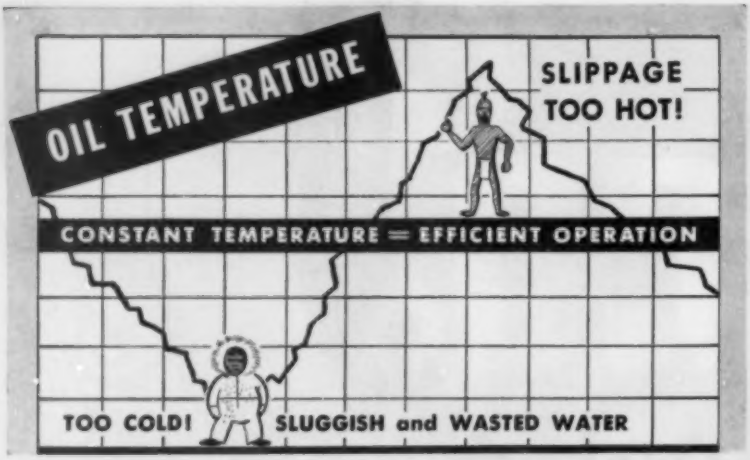
Circle 154 on Reader Service Card

FLEXIBLE TUBING . . . which is corrosion resistant; unaffected by oils, hydraulic fluids, acids and solvents, is listed in a brochure from Polymer Corp. of Pa., Reading, Pa. Size tables, photos, and uses of Nylaflow tubing are covered. Tools for cutting, bending and shaping the tubing, and local sales representatives are also included.

Circle 155 on Reader Service Card

Continued on page 56


GACO
HYDRAULIC PACKINGS
GEORGE ANGUS & Co LTD
OIL SEAL DIVISION
NEWCASTLE UPON TYNE, 6.
ENGLAND
GACO



Keep OIL TEMPERATURE CONSTANT *for* EFFICIENT *Trouble-free* OPERATION

Bring your existing equipment up to the hydraulic fluid cooling standards recommended by J.I.C.* with a Sterlco Automatic Temperature Control Unit installed in your heat exchange system. Easy to install . . . eliminates the human element at the cooling valve.

Remember, oil too hot means slippage . . . too cold means sluggish operation with wasted cooling water.

Sterlco® SERIES 150E TEMPERATURE CONTROL

COMPLETELY AUTOMATIC — Once installed and set at proper temperature no further adjustment necessary.

SELF-CONTAINED — Consists of thermostat bulb, capillary tube and valve.

EXTREMELY COMPACT — Does not require great space for installation.

MOUNTS ANY POSITION — Works as well vertically (right side up or upside down) —horizontally or at an angle.

INEXPENSIVE, TOO! You will be amazed at the low cost of the Sterlco Series 150E Temperature Control. In actual operation an installation of several units has paid for itself in less than 3 months in savings of water alone.

SEND FOR COMPLETE DETAILS NOW

* J.I.C. (Joint Industry Conference) paragraph H5.10 states: "When heat exchangers are used, they shall be equipped with suitable automatic thermal controls."

MANUFACTURERS OF TEMPERATURE CONTROL EQUIPMENT SINCE 1916

INDUSTRIAL CONTROL DIVISION
STERLING, INC.
3742 N. Holton Street • Milwaukee 12, Wis.

Useful Literature / continued

SEAL CATALOG . . . covering the complete line of Bellofram seals has been released by Bellofram Corp., Burlington, Mass. Catalog BF 200 gives a short history and basic description of the seal plus advantages, operations and applications. The fully illustrated catalog is divided into separate sections for each type seal, and includes size tables and installation information.

Circle 156 on Reader Service Card

ELECTRIC THERMOSTATS . . . are described in 4 page bulletin RT-810, issued by Robertshaw-Fulton Controls Co., Greensburg, Pa. B10 and B20 thermostats are designed for use in a variety of commercial and industrial equipment. They are available in temperature ranges to 550 F, and are rated at 20 amp, 115 vac, and 15 amp, 230 vac. The bulletin contains general and cutaway views, tables of dimensions and other data.

Circle 157 on Reader Service Card

AUTOMATIC FILTERS . . . for use with lubricating oils and coolants are shown in a bulletin from Bowser Inc., Fort Wayne, Ind. The filters feature automatic cleaning and large sump capacity, and the bulletin reviews degrees of filtration available, sizes, and performance data. Photos and dimensional drawings are included.

Circle 158 on Reader Service Card

COUPLINGS . . . are described in two bulletins available from Zalo Mfg. Co., Cleveland. The silver sleeve series 250, and black sleeve series 251 are shown in bulletin 250-1. These pneumatic couplers feature quick connect and disconnect, 360 degree swivel, and self sealing. Air blow guns are also covered. The second bulletin includes dimensional drawings, photos and size tables of the PT series couplings.

Circle 159 on Reader Service Card

For more reviews of FREE LITERATURE turn to page 136

Factory Mutual Laboratories, Norwood, Mass.

Factory Mutual Laboratories test

SHELL IRUS FLUID 902

the low-cost, fire-resistant hydraulic fluid

Factory Mutual Laboratories, the well-known industrial testing authority, recently evaluated Shell Irus* Fluid 902.

The tests performed included:

1. **Flash Point**
2. **Autoignition**
3. **Flame Propagation**

The Shell Industrial Engineer can give you more information about these tests.

*Trademark

In plant after plant, users find that Shell Irus Fluid 902 is comparable in fire resistance to much higher-priced hydraulic fluids.

SHELL OIL COMPANY

50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL

Circle 96 on Reader Service Card

New Products

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

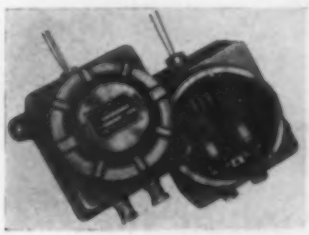
GEARMOTOR . . . is simple and versatile

Features: Designed to minimize machine down-time, only four bolts are loosened to free this motor from the end shelf and uncouple the flexible coupling. The motor may then be removed and replaced with another in a matter of minutes. Mounting slots in the end shelf are standardized to conform with standard NEMA dimensions. Capacities range from 1 to 75 hp. Each has an output speed range of from 350 to 7½ rpm. Double and triple reduction units are available in foot and flange mountings, vertical or horizontal. Speed reducer ratios to 1478:1 can be changed with standardized drive components. Standard gearhead components allow minimum spare part inventory. A flexible coupling absorbs any misalignment.

Howell Electric Motors Co.
Howell, Mich.

Circle 200 on Reader Service Card

PRESSURE SWITCH . . . for explosive atmospheres



Designation: Model 932

Features: Differential pressure for operation may be provided by two variable pressures or a variable and a reference pressure. Available in four classes of proof pressures from 500 to 12,000 psi, the switch will open or close a circuit on increasing or decreasing pressure difference from 15 to 10,000 psi at any point within the adjustable range of the model selected.

Design: Two parallel bourdon-tube sensing elements provide extreme repetitive accuracy. Operation may be in any position, simplifying installation and facilitating portable installations. No balancing or levelling is necessary. The entire mechanism is housed in an explosion proof enclosure.

Barksdale Valves
Los Angeles, Calif.

Circle 201 on Reader Service Card

AIR-HYDRAULIC POWER UNIT . . . has accurately adjustable pressure

Features: Designed for varied utilization, simplicity of operation, and ease of maintenance, this unit features a demand system with constant pressures to 3000 psi. The aluminum cabinet is mounted on four casters and has hinged access doors for ease of maintenance. System pressure is accurately adjustable to 25 psi. The system is powered by a piston-type air-hydraulic booster pump with an automatically-operated air selector valve. Standard equipment includes dial pressure gage, hydraulic hoses, pressure control valve, two accumulators, exhaust mufflers, air cleaner lubricator, filter vented cap and a reservoir.

Specifications: Dimensions 20 x 12 x 14-in. high; weight 75 lbs; 1/4-in. pressure and return hoses; 3/8-in. air supply hose; one gallon reservoir.

Hi-Shear Rivet Tool Co.
Torrance, Calif.

Circle 202 on Reader Service Card

Continued on page 60

SUMP TYPE
(Cutaway)

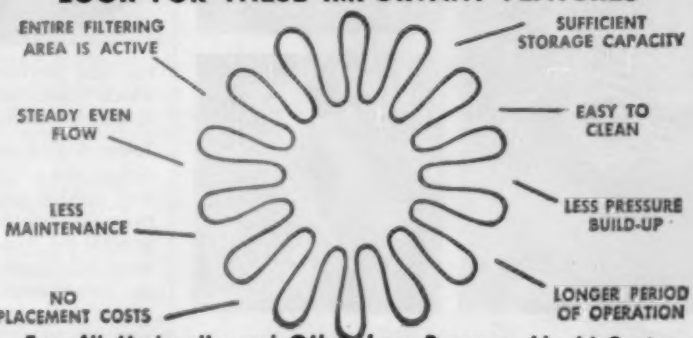
When You Need A Filter— Get The Advantages Of Marvel SYNCLINAL Design

It's BALANCED

For Top Performance!

LINE TYPE
(Cutaway)

LOOK FOR THESE IMPORTANT FEATURES



For All Hydraulic and Other Low Pressure Liquid Systems

In the selection of a filter to obtain maximum efficiency and quality, the most important point to consider is a specific type filter that will offer greatest *ACTIVE* filtering area with ample storage capacity for filtered out particles, rather than total filtering area alone. Over 750 Original Equipment Manufacturers install Marvel Synclinal Filters as Standard Equipment because they are designed to give this all-important balance for greatest efficiency in filtration of liquids in all hydraulic and other low pressure circulating systems. Flow of liquids is maintained at a constant, steady rate of speed produced by the pump which brings about the desired effect of a gentle, evenly distributed accumulation of filtered out particles against the entire filtering surface with less restriction of flow. Result—longer periods of productive operation at minimum maintenance down-time. If this imporant balance is lacking due to efforts to cram too much filtering mesh for the sake of total rather than active area, filters soon become clogged causing pressure build-up, turbulent flow and in general decreases the efficency of operating equipment. Depend on Marvel Synclinal Filters For All Your Filtration Requirements. They meet J.I.C. Standards.

EASY MAINTENANCE

Both sump and line types may be easily disassembled, cleaned and reassembled by any workman, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

WATER FILTERS

Both sump and line type filters have been adapted for use in all water filtering applications. No changes have been made in the basic, balanced synclical design.

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 20 to fine 200.

FILTERS FOR FIRE-RESISTANT HYDRAULIC FLUIDS

Marvels most recent development is a filter for the efficient filtration of all types of fire-resistant hydraulic fluids.

IMMEDIATE DELIVERY!
As in the past, Marvel continues to offer IMMEDIATE DELIVERY.

Catalogs containing complete data available on request.

Write or Mail Coupon.

MARVEL ENGINEERING COMPANY

7227 N. Hamlin Ave., Chicago 45, Ill. **PHONE: Juniper 8-6023**

Without obligation, please send me complete data on Marvel Filters, as indicated: (AH-8)

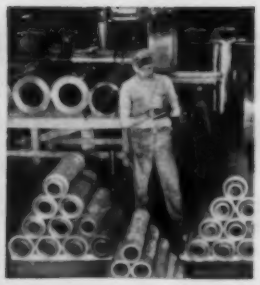
- ☐ Catalog #108—For Hydraulic Oils, Coolants, Lubricants.
- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
- ☐ Catalog #301—For Water

Name _____ Title _____

Company _____

Address _____

City _____ State _____



You machine better and faster with

SHENANGO CAST BAR STOCK

Because Shenango tubular stock is *centrifugally* cast, impurities and pockets are *forced* out of the metal in the molten stage. Moreover the grain is finer, pressure-dense and more uniform. This results in smoother machining, better control, and less waste of time and metal.

Made of high-strength Meehanite metal or long-lasting bronze, Shenango tubular stock comes in a *complete* range of I.D. and O.D. sizes. Its lengths go up to 20 feet, depending on diameter, which keeps cut-off waste to a minimum.

While the demand for Shenango bar stock is largely tubular . . . solid round, square, hexagonal, rectangular and other special shapes are readily available.

It will pay you to specify Shenango bar stock for longer wear, greater strength, fewer rejects . . . and lower over-all cost. For full information, write to: *The Centrifugally Cast Products Division* of The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

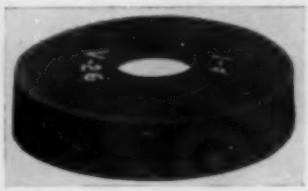
COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

New Products / continued

CUPS & PACKINGS

. . . have greater heel density

Features: Made of Sirvis or Sirvis-Conpor (elastomer impregnated) mechanical leather, the cups are pre-formed on special dies to produce a sharp, rather than round heel. Advantages of the molded design are greater density at the heel of the



cup, and pre-forming to the shape which round-heel cups are forced to assume under pressure.

Tests: A C/R cup of conventional design, and a C/R cup of the sharp-heel molded design were run in a hydraulic cylinder for 3000 cycles at 6000 psi. Results showed marked wear and distortion at the heel of the conventional cup, little if any appreciable wear on the molded design. Photo shows the sharp heel cup after this test.

Chicago Rawhide Mfg. Co.
Chicago, Ill.

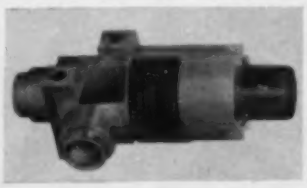
Circle 203 on Reader Service Card

SMALL SHUT-OFF VALVE

. . . has no moving seals

Designation: MV-126B

Features: Completely free of moving seals, the miniature solenoid shut-off valve weighs only 6½ oz.



Pressure drop is 4 psi at 2.1 gpm flow. It is operated by a 24 vdc 1 amp power supply at pressures from 0 to 500 psi and temperatures from —65 F to 350 F. Now used in fuel starter systems, it is also applicable to hydraulic, dessicator, and steam systems with flange, plug-in, and line mounted versions.

Marotta Valve Corp.
Boonton, N. J.

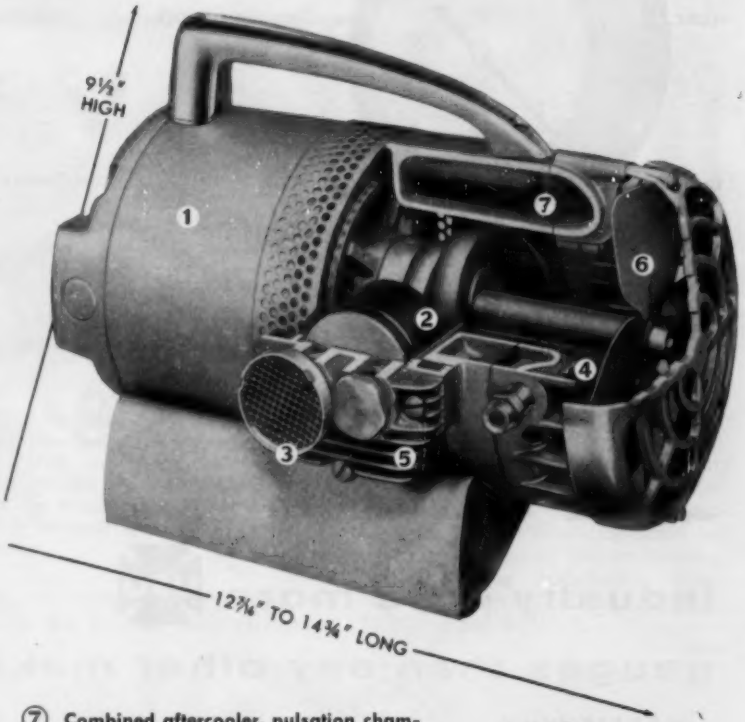
Circle 204 on Reader Service Card

Continued on page 62

Oil-Free COMPRESSED AIR

from a portable or built-in unit

No more oil-spoiled work! Here is a compressor which doesn't require lubrication of any kind—eliminates an oil separator, *ends expensive lubrication maintenance!* Whether your need is for a portable or built-in source of compressed air, the compact, lightweight B&G Oil-less Compressor assures cleaner, cooler, drier air and smoother operation.



① **Specially designed motors.** Built by B&G—noted for dependability. Ball bearings are *permanently* grease packed.

② **Graphite piston rings and skirts.** Made of a special composition which does not need lubrication. Operate for years without destroying the mirror-finish of the cylinder walls. Piston ring joints are self-sealing—reduce blow-by to a minimum.

③ **Dry valve construction.** Inlet and exhaust valves are positive-sealing without presence of oil. Precision lapped—self-cleaning—no rubbing parts.

④ **Safety valve.** (Not visible.) Provides constant bleed-off at maximum pressure. Also acts as automatic moisture drain.

⑤ **Bi-metal cylinder head.** Deep-finned aluminum head transfers heat faster. It is cast around the cast iron cylinder, making a leak-proof shrink-fit...no gasket needed.

⑥ **Blast cooled.** The fan blasts great volumes of air over the pulsation chamber, connecting rods, bearings, cylinders and motor. Low temperature operation assures higher efficiency, longer life.

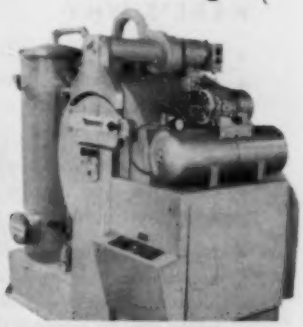
⑦ **Combined aftercooler, pulsation chamber, moisture separator.** Cooler, drier air is delivered at smooth, uniform pressure because of this integrated design.

For complete information on B&G Oil-less Compressors and Vacuum Pumps, send for Catalog GO-1156

Cart mounted B&G Air Compressor

B&G "Duplex Unit" mounted on horizontal tank

New type air stapler with air supplied by B&G Compressor



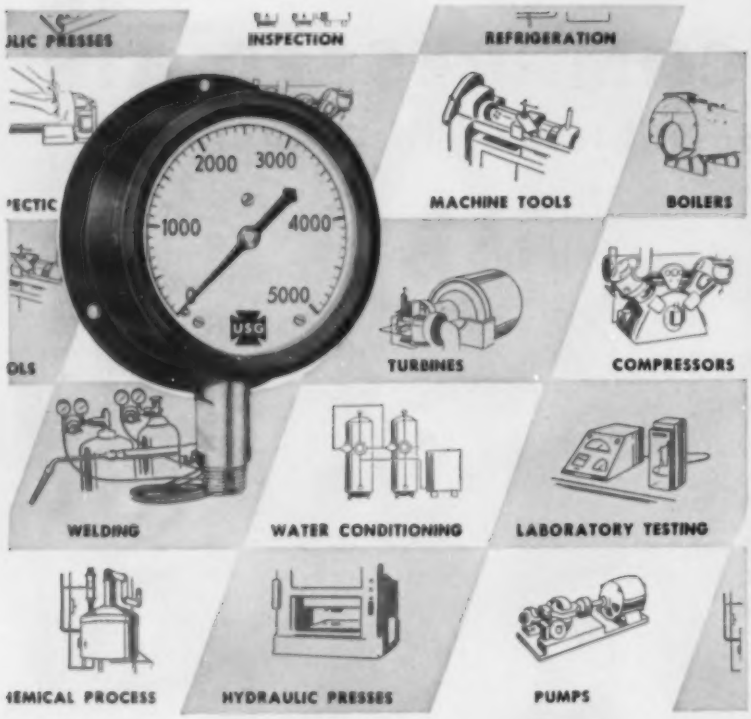
B&G Compressor built into dry cleaning machine

Oil-less AIR COMPRESSORS

BELL & GOSSETT COMPANY

Dept. EX-66, Morton Grove, Illinois

MAKERS OF HEATING AND COOLING SPECIALTIES, PUMPS, HEAT EXCHANGERS



industry buys more USG gauges than any other make

HERE'S WHY

- Practically all industrial gauge requirements can be met by USG.
- For high sustained accuracy . . . for long, trouble-free service under severe temperature and atmospheres . . . there's the Supergauge and Solfrunt Series.
- For less exacting applications there are thousands of gauges . . . cast case and drawn steel case units . . . each with components specially qualified for its particular function.
- Every gauge is backed with more than 50 years experience in gauge construction . . . with research that puts every type of gauge through simulated service conditions for months before it is marketed . . . with quality control that enables USG to guarantee performance in service.
- Buy USG gauges . . . pressure and temperature pilots, recorders and controllers . . . transmitters and thermometers . . . and be assured of guaranteed satisfaction in quality, performance and dependability.

Consult the "Yellow Pages" of your phone book for the name of your USG distributor. Call him or write the factory for catalogs.

Supergauge and Solfrunt Reg. T.M.

USG UNITED STATES GAUGE
Division of American Machine and Metals, Inc.
Sellersville, Pa.
Home of the SUPERGAUGE

MORE THAN 50,000 TYPES OF GAUGES • SUPERGAUGES • SOLID FRONT GAUGES • RECEIVER GAUGES • TEST GAUGES • RECORDERS • CONTROLLERS • TRANSMITTERS • PSYCHROMETERS • AVIATION INSTRUMENTS

New Products continued

BRASS HOSE FITTINGS

. . . made in any shape

Features: Fluid passages are machined to maximum size, for a greater flow of air or water. Elbows and shapes are formed by silver

soldering bar stock components. This method permits the fabrication of various combinations of hose stem outlets to pipe sizes. Also, off-standard shapes, sizes and lengths of elbows can be made.

Service Mfg. & Supply Co. Detroit, Mich.

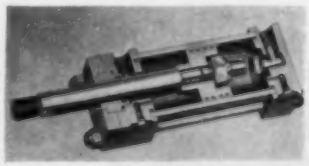
Circle 205 on Reader Service Card

CYLINDERS

. . . for 2000 to 3000 psi service

Designation: Series H

Features: Cylinders are available with single or double action. Single acting have spring or non-spring returns, depending on application. Cushions can be at both ends or at either end of the cylinders. Mount-



ing dimensions are the same for cushioned or non-cushioned types. Piston rod end styles are interchangeable with those of any other leading manufacturer. End caps and mountings are of bar stock steel, and cylinder barrels are of cold rolled steel tubing, honed to 10 microinch finish. Bronze piston rod bearing and a one-piece alloy-iron piston with step-cut piston rings are standard. Large cylinder ports can be rotated to any of four positions, 90 degrees from each other. Cylinders conform to all JIC standards.

Milwaukee Cylinder Co. Cudahy, Wis.

Circle 206 on Reader Service Card

Continued on page 65

Integral Flow Control Now Available In Larger Volume Vickers Vane Pumps

For power steering of vehicles with very heavy front axle loading

Assures Optimum Steering ...Simplifies and Reduces Cost of Installation

Flow control in hydraulic power steering circuits is necessary because power steering pumps vary in volume delivery according to engine speed. To assure adequate steering power while maneuvering in tight places, the pump must be chosen to provide ample volume at engine idle speed. The much greater flow at high speed, if not controlled, results in unsatisfactory and sometimes unstable steering performance. Further disadvantage is undue heating of the hydraulic fluid.

FIG. 1—Vickers Series V200 Vane Pump with integral flow control and relief valve. Available in 3 sizes with nominal rated capacities of 5, 8 and 11 gpm.* Controlled flow rates of all sizes are 2, 4, 6 and 7 gpm at relief valve setting of 750 or 1000 psi.

***Rating at 1200 rpm.**

An integral flow control valve for limiting flow to the steering device has always been a feature of the small Vickers Vane Type Pumps used in passenger car steering. Excess fluid resulting from higher engine speeds is returned to the reservoir with minimum pressure loss and very little heating. Previously, the larger pumps used for steering heavy vehicles did not have an integral flow control valve. It was installed as a separate unit.

Now Vickers offers larger pumps—the V200 Series—with integral flow control (See Fig. 1), which simplifies and substantially reduces the cost of installation. Smaller hydraulic lines to the steering booster are made possible by limiting flow in this part of the circuit.

For applications requiring two

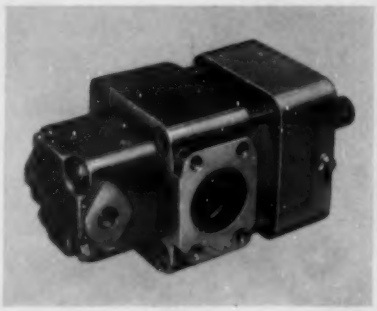


FIG. 2—Vickers Double Pump for operating two independent hydraulic circuits from one power source. Series V2200, V3200 and V4200 are available with the smaller pump (Series V200) having integral flow control for power steering.

separate hydraulic circuits, the Vickers line now includes three new series of double pumps (See Fig. 2). Integral flow control is furnished in the small-volume section used for power steering. The large-volume section, in conjunction with Vickers multiple unit valves is used for operating the vehicle's tools.

Both the single and double pumps with integral flow control have all the features and characteristics responsible for the outstanding popularity of Vickers Vane Type Pumps. Higher efficiency means more work from less power. Hydraulic balance eliminates pressure induced bearing loads, provides longer life and reduced maintenance. Automatic wear compensation maintains "new-pump" efficiency throughout a very long life. Starting in cold weather is easier.

More Vickers designed pumps than all other makes combined are used for hydraulic power steering. Ask for new installation drawings M192680, M192856, M192857, M192858 and #1617-S.

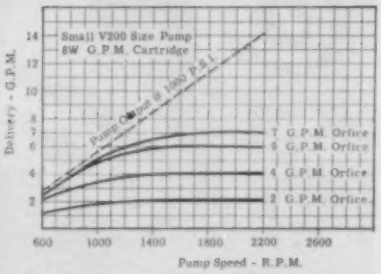


FIG. 3—Typical performance curves of Vickers V200 Pump with Integral Flow Control and 8 gpm cartridge. Delivery rises quickly with speed and then holds at controlled flow rate setting.

7777

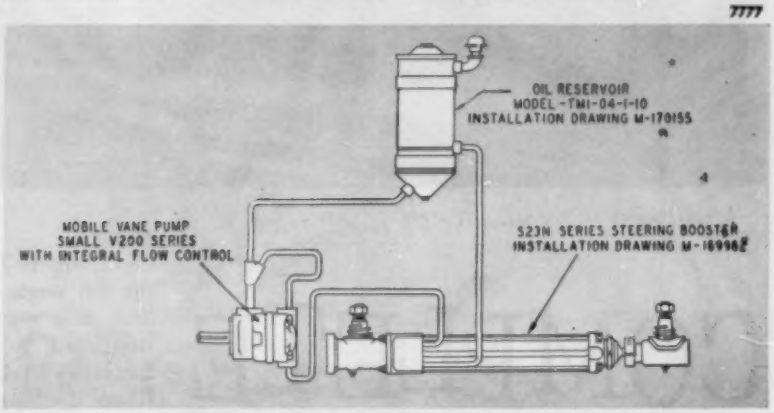


FIG. 4—Preferred circuit when using Vickers Series V200 Vane Pump with integral flow control and Vickers S23N Hydraulic Power Steering Booster. This model is without relief valve because the pump contains such a valve.

VICKERS INCORPORATED

DIVISION OF SPERRY RAND CORPORATION

Mobile Hydraulics Division

ADMINISTRATIVE and ENGINEERING CENTER

Department 1474 • Detroit 32, Michigan

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IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto and Montreal

COMPLETE

NOT only is The Weatherhead Company known as the only single source for complete lines of hydraulic hose, hose assemblies and fittings; it is also widely recognized for its continuing efforts to expand the company's services to its customers. An example is the recent development and establishment nationally of hose assembly swaging service at the distributor level.

Weatherhead distributors are now equipped with swaging facilities to handle orders promptly for factory-equivalent permanently attached hose assemblies as needed in any size, type, length or pressure. This service combines with Weatherhead volume factory production to round out a most effective supply link between producer and user.

WEATHERHEAD

FIRST IN HYDRAULIC CONNECTIONS

THE WEATHERHEAD CO., FORT WAYNE DIVISION
Dept. A-9, 128 West Washington Blvd., Fort Wayne, Indiana
In Canada: The Weatherhead Co., Ltd., St. Thomas, Ontario

Circle 121 on Reader Service Card

New Products continued

HYDRAULIC CYLINDERS

. . . in miniature sizes

Features: 3000 psi, non-cushioned cylinders are offered in five bore sizes: ½, ¾, 1, 1-¼, and 1-1/2-in. All except the 1/2-in. size

have standard 2:1 rod. Rated at 3000 psi continuous service with peaks to 10,000 psi, cylinders are available in strokes to 36-in.

Oil-Dyne, Inc.
Chicago, Ill.

Circle 207 on Reader Service Card

HAND PUMP

. . . for pressures to 10,000 psi

Designation: Model 1687

Features: Variable-leverage hand pump has an internal toggle linkage and a capacity of 0.475 cubic

inches per cycle. Designed primarily for cranes, stackers, winches, and other material handling applications, it is normally used with a 28-in. length of 3/4-in. pipe for a handle. Handle can move through a total arc of 72 degrees. At 10,000 psi, the operator uses the left hand portion of the stroke for a 3.5:1 mechanical advantage. When lifting light loads, the right hand portion of the stroke gives three times the usual speed.

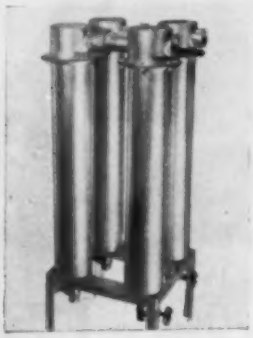
Mechanisms Co.
Uhrichsville, Ohio

Circle 208 on Reader Service Card

WATERLESS AFTERCOOLER

. . . for air lines

Specifications: Filter is a 36-in. cylinder, 6-in. in diameter, which contains a smaller cylinder having a perforated bottom filled with Fiberglas. Units are made of 16-gage carbon steel and are tested to 500 psi. internal pressure. Aftercooler consists of four standard air filters, connected in series and



mounted to occupy floor space of 18-in. square.

Features: Compressed air enters the top, flows downward through the Fiberglas. The filters in series act as condensors. In addition to oil removal, they condense water vapor and remove it. This unit accomplishes a rapid heat transfer. When the unit is connected, an air gage is put on the inlet side and another on the outlet side. Any considerable difference in pressure between these two gages indicates that the fiberglas has absorbed enough oil to be changed.

Airlenco, Inc.
Elyria, Ohio

Circle 209 on Reader Service Card

For more NEW PRODUCT reviews turn to page 126

WEATHERHEAD

ONLY COMPLETE SINGLE SOURCE FOR HYDRAULIC HOSE LINES AND FITTINGS

STEEL TUBE FITTINGS
Ermeto® Flareless and
Flare-Twin S.A.E. 37° Flared

BRASS TUBE FITTINGS
S.A.E. 45° Flared • Inverted Flared • Pipe • Compression • Selfalign® • Threaded Sleeve • Drain and Shutoff Cocks

HYDRAULIC HOSE, ENDS, ASSEMBLIES
Bulk Hose • Reusable Hose Ends
Crimped and Swaged Hose Assemblies

PUSH—PULL CONTROLS

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WAREHOUSES
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DISTRIBUTORS
Throughout The World

FORT WAYNE DIVISION
Fort Wayne, Indiana

POWER by POWER JACKS

HYDRAULIC PUMPS of proved efficiency for hand or power operation

TECHNICAL DATA

Normal operating pressure . . 1,500 lbs. sq. in.

Maximum operating pressure (Blow Off) . . . 2,500 lbs. sq. in. *(or to specification)*

Output complete stroke . . . . . ·825 cu. ins.

Effective piston area . . . . . ·600 ins.

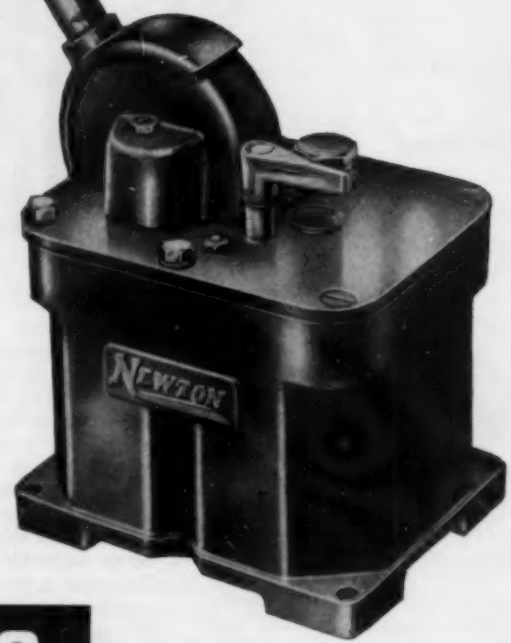
Handle leverage ratio . . . . . 16—1

Alternative fluid capacities in pints . . . 2¾ pts., 6 pts., 16pts., 24 pts., 32 pts.

Larger capacities to special order.

Vertical or horizontal pump handle

JACKS from 1 TON to 5 TONS in a variety of stroke lengths



POWER JACKS LIMITED

VALETTA RD·ACTON·LONDON·W.3·ENGLAND

TELEGRAMS: NEWSORBER, EALUX, LONDON, ENGLAND

A NEWTON PRODUCT

Send for illustrated technical brochure Publication No. F/223

Circle 82 on Reader Service Card

STRONGER and SAFER for every high pressure pipeline duty...

...because they are drop forged by Vogt

Send for Catalog F-9

Constantly imitated but never duplicated, Vogt drop forged steel fittings and flanges have unmatched strength and toughness for your most severe pipeline duties. Laboratory controlled materials and Vogt's special forging techniques assure products which are always uniform in structure, fine grained, and free from porosity. Thereby the shocks and stresses imposed by high pressures and high temperatures are easily withstood, and with stubborn resistance to erosion and corrosion. Consult Catalog F-9 for our complete line of fittings and flanges.

For a copy of Vogt Catalog F-9 address Dept. 24A-FAH.

HENRY VOGT MACHINE CO., P.O. BOX 1918, LOUISVILLE 1, KENTUCKY

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va., Cincinnati, San Francisco

OTHER VOGT PRODUCTS

Drop Forged Steel Valves — Petroleum Refinery and Chemical Plant Equipment — Steam Generators — Heat Exchangers — Ice Making and Refrigerating Equipment.

Vogt

DROP FORGED STEEL

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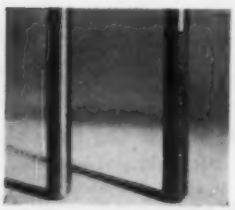

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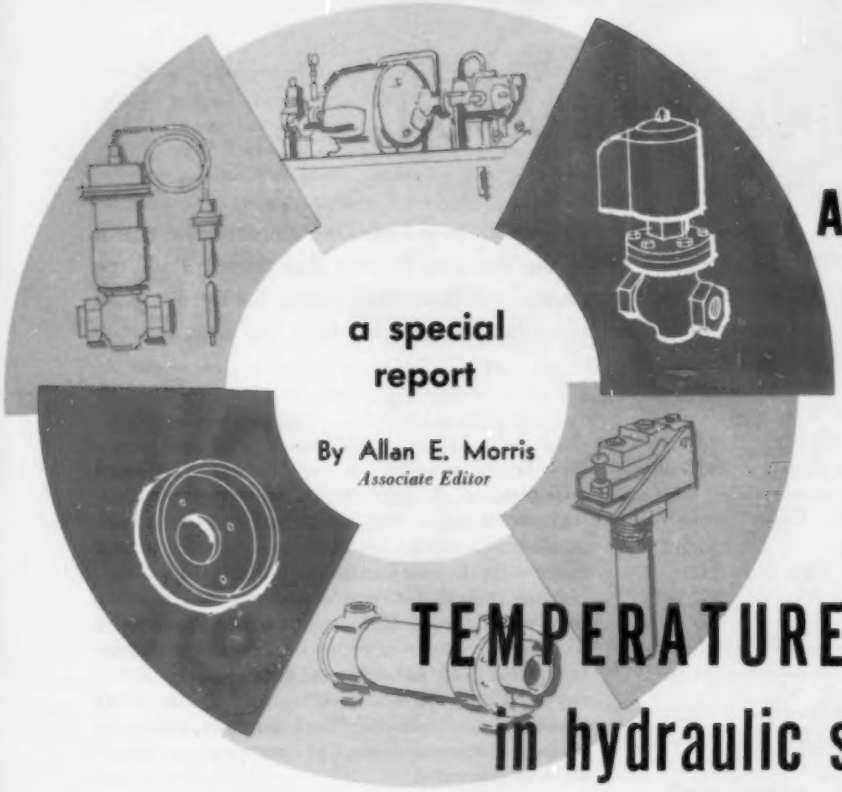

Applied Hydraulics
AUGUST 1957

a special report

By Allan E. Morris
Associate Editor

TEMPERATURE CONTROL in hydraulic systems

ONE of the engineer's primary objectives is designing for greater efficiency. Not only must a hydraulic system be designed to do the job, but it must do it with as little waste power as possible. Sometimes, because of other machine requirements, a compromise in efficiency must be made. This means that if the wasted power, which shows up as heat, cannot be dissipated naturally or carried away by surrounding air, equipment must be added to the machine for this purpose.

This report has been prepared to indicate some of the methods for determining how much heat will be generated, whether auxiliary oil coolers will be required, and how to select these and their additional controls.

Although many of the methods explained here result in rough approximations and are based on previous experience and designs, they do give ideas on how to maintain fluid temperature for best operation.

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HEAT GENERATION

Where does heat come from in a hydraulic circuit? How can it be estimated before the machine is built and tested? Here are methods for determining heat generation during the development stage when corrections can be made to obtain the most economical design.

AMONG the many sources of heat in a hydraulic system, the most important are those where fluid passes through an orifice. These can be especially troublesome when there is a large pressure drop as in a relief valve. This large pressure drop means high velocity, high friction, and rapid heat generation.

Another source of heat is the pump where heat is generated because of slip and bearing friction.

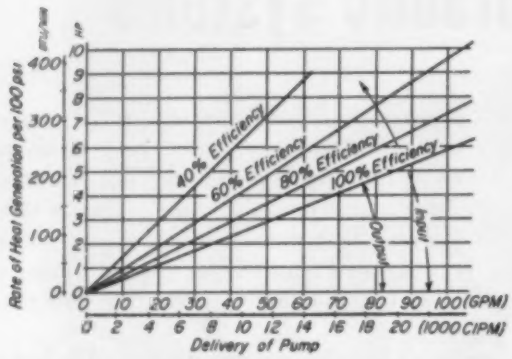


FIG. 1. HEAT GENERATED BY AUXILIARY PUMPS is determined from this graph. Auxiliary pumps are those in which the entire input produces heat.

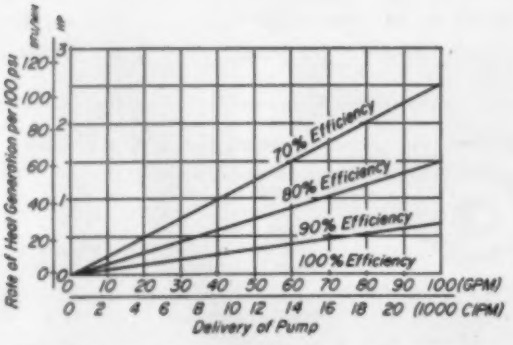

Rate of Heat Generation per 100 psi
Btu/sec
HP
70% Efficiency
80% Efficiency
90% Efficiency
100% Efficiency
0 10 20 30 40 50 60 70 80 90 100(GPM)
0 2 4 6 8 10 12 14 16 18 20 (1000 CIPM)
Delivery of Pump

FIG. 2. HEAT GENERATED BY POWER PUMPS is determined from this graph. Power pumps are those in which only the losses cause heat.

How troublesome this is depends on pump speed and pressure. A third source of heat, though usually not a major one, is external equipment such as molten metal, furnaces, or welding guns located close to the hydraulic system.

Many rules of thumb are used in estimating how much heat will be generated. Usually these are based on the size of the electric motor driving the pump and range from 15% loss to 100% depending on the equipment and duty cycle. More analytical methods are based on tests and operation of similar equipment to determine the amount of heat generated.

• **Heat Generated by Auxiliary Pumps**—One of these methods divides pumps into auxiliary units and power units. Auxiliary pumps are considered to be those whose entire input generates heat, such as those used to supercharge the system, supply lubricating fluid to a larger pump when it runs at zero delivery for long periods, circulate oil through the filter, and supply oil for valve operation and to control the main pump stroking mechanism. These are often gear pumps incorporated in the same housing with a variable delivery piston pump.

None of these functions produce external work, so that the entire output of the auxiliary pump is considered as heat. The oil flow through the filter produces turbulence in the flow control and filter element resulting in 100% heat. Even shifting of valves develops 100% heat because all the work done in shifting the valve plunger goes to overcome friction on the plunger walls and hydrodynamic forces in the oil. The pump stroking mechanism merely overcomes friction resulting in heat in the pump casing.

In addition to the output, the input of auxiliary pumps must be considered. Since the overall efficiency of some auxiliary pumps is as low as 45%, the input losses are sometimes appreciable. Figure 1 has been prepared from calculations to determine heat generated by auxiliary pumps. The area below the 100% efficiency line represents the heat loss due to the output of the pump. The area above the 100% efficiency line represents the additional heat due to the input losses of the pump.

• **Heat Generated by Power Pumps**—Pumps whose output results in external work are classified as power pumps. Only the losses in these pumps cause heat. Knowing the efficiency of the pump, Figure 2 can be used to determine the heat generated. Most piston pumps have an over-all efficiency between 85 and 91%, although this varies considerably with pressure, speed, and oil viscosity.

• **Heat Generated in Pipes**—Pipes cause heat because of turbulence and friction of the fluid. Although mathematical methods can be applied to determine piping and valve losses, Figure 3 simplifies the job and permits estimating the heat generation with reasonable accuracy and a minimum of effort.

If the flow rate and the pipe size are known they can be applied to the lower scale and sloping lines of the graph to find the horsepower loss per foot of pipe. Multiplying this loss by the length of pipe gives the total loss. If the flow is not continuous, some allowance must be made for flow variations.

The graph is based on fluid at 200 SSU viscosity. If the operating viscosity is different from this and flow is laminar, a direct proportion correction in horsepower can be made because resistance varies with viscosity.

• **Duty Cycle Method**—Another method for determining the heat developed in a machine is based on the delivery of the pump and the mean effective pressure.This pressure is determined from an oscillograph charting the entire machine cycle as shown in Figure 4. The oscillograph is for a stretch bender with a single pump and accumulator. In stretch bending there must be a controlled slow rate in the final stretch when passing through the elastic limit of the stock. This explains the sinusoidal flat top at 700 psi when the pump is actually spilling half its rated volume over the relief valve. The mean effective pressure is then used in the formula:

$$BTU/hr = 1.482 \times K \times PSI \times GPM \quad \text{.....(1)}$$

The constant, 1.482 is a conversion factor determined from the conversion of 778 ft-lb to approximately 1 BTU. The factor, K, is based on several design factors and varies from 1.03 for a well designed machine to as high as 1.8 for a poorly designed machine. One factor is the amount of entrapped air. It has been found that excess entrapped air has raised the tank oil temperature as much as 25%. Other factors affecting the value of K are undue restrictions, and undersize control valves, fittings and tubing.

When compared with previous experience, the figure calculated from this formula gives a good indication of what the heat dissipation problem will be. At values of 5000 BTU/hr there is little problem, and the machine can be expected to dissipate this heat with no special design. The average machine will run about 8000 BTU/hr and some ingenuity in system design should be applied. Above 10,000 BTU/hr some thought must be given to maintaining summer temperatures of 115 F and machines running above 15,000 BTU/hr will almost always require the addition of an oil cooler and controls.

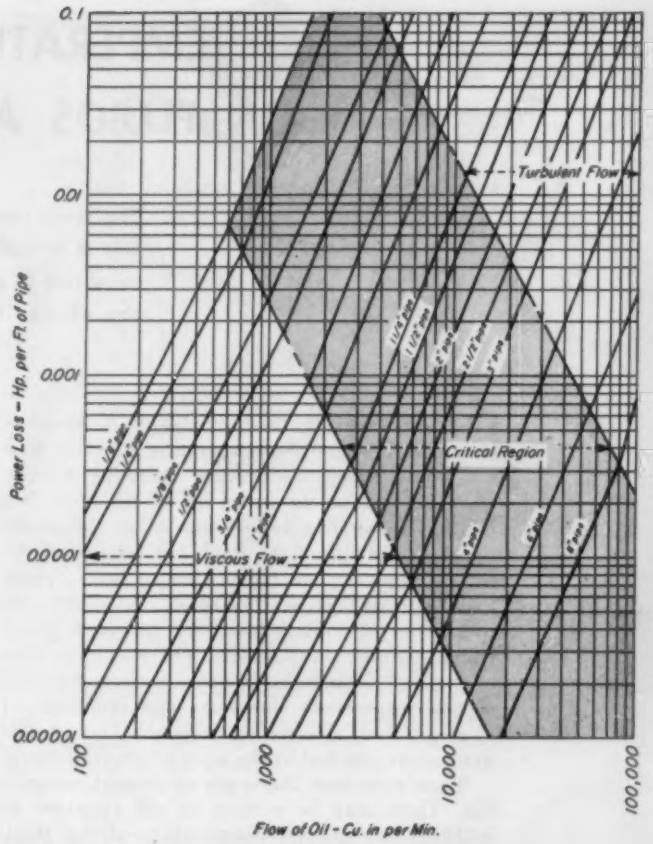


FIG. 3. HEAT GENERATED IN PIPES is determined from this graph. Graph is based on fluid with viscosity of 200 SSU.

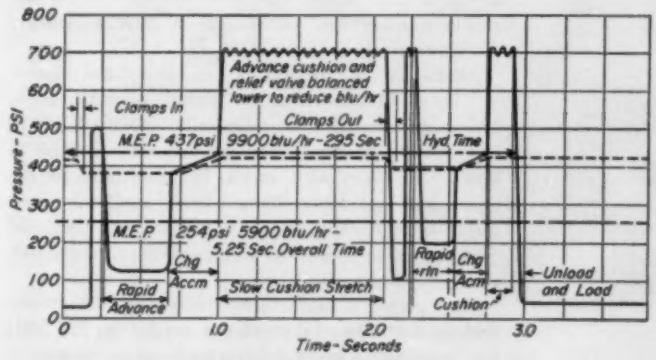


FIG. 4. PRESSURE-TIME OSCILLOGRAPH permits calculating mean effective pressure for machine cycle. Graph is for a stretch-bender.

TEMPERATURE EFFECTS ON FLUIDS AND PACKINGS

The main reason for controlling temperature in a hydraulic system is to maintain correct fluid viscosity and limit oxidation. A good rule to keep in mind is that for every 18-degree temperature rise above 140 F, life of the fluid is approximately cut in half.

LIFE of a hydraulic fluid depends on its chemical composition and the temperature at which it is used. The higher the average operating temperature, the shorter the useful life of the fluid. Not only does operating temperature affect the oxidation rate and life of the fluid, but because of decreased viscosity at higher temperatures, pump wear and leakage are increased. Petroleum oils which are not inhibited, oxidize and form gums, resins, varnishes, and sludges. The acid value rises as these products form. In many cases, metals like copper, magnesium, aluminum, and cadmium act as pro-catalysts accelerating oxidation. These metals in turn, are attacked by the acids which are formed.

When water-base fluids are overheated, water is lost. There may be a drop in pH (increase in acidity) and gradual deterioration of the fluid. Emulsion type fluids lose water on overheating and are subject to separation. The remaining mixture of petroleum oil and emulsifiers withstands deterioration quite well, and tests of these fluids at 250 F have shown very little change in neutralization number and no sludge or gum formation after one week.

Maximum and minimum viscosities and viscosity index are specified by pump manufacturers. Minimum viscosity is frequently specified as 70 SSU with maximum start-up viscosity limited to 4000 SSU. Viscosity index is important in determining operating temperature limits because fluids with higher viscosity indexes can be used over wider temperature ranges without exceeding viscosity limits.

One pump manufacturer's viscosity recommendations for industrial machines are 150 to 225 SSU for vane units on machine tools at pressures to 1000 psi, and 275 to 315 SSU for presses and other heavy machinery, or machine tools operated above 1000 psi. For all industrial machines operated by piston type pumps and motors, a fluid viscosity of 275 to 315 SSU is recommended. For machines operated by gear type fluid motors a viscosity of 150 to 315 SSU is recommended. All viscosities are specified at 100 F, and ambient air temperature is assumed to be 40 to 90 F.

Viscosities and viscosity indexes of some of the fire-resistant fluids can vary considerably from petroleum-base fluids. Figure 6 indicates viscosity-temperature characteristics of two typical synthetic fluids, a water base fluid and an emulsion. One consideration in operating water-base and water-emulsion type fluids at higher temperatures is the evaporation of water and consequence loss of fire resistance. In complying with the generally accepted viscosity limits of 4000 to 70 SSU, one manufacturer of synthetic fluids supplies products of varying viscosities for the temperature ranges shown in Table I.

Three of these fluids fall well within the generally accepted temperature limits of 60 to 130 F. Some type of cooling or heating would probably have to be used with the other fluids.

The chemical structure of these fluids makes them less sensitive to elevated temperatures than those containing water. Providing that viscosity requirements can be met, they may be used in certain cases in continuous service at temperatures to 250 F. Of course the oxidation rate is accelerated at these higher temperatures and the useful life is shortened.

When used at lower temperatures, they tend to become more viscous with decreasing temperatures than petroleum fluids. Therefore it is essential to provide some form of immersion heating where low temperatures may be encountered to avoid the danger of pump cavitation and wear on start-up. The operating temperature of water base fluids should be limited to 130 F with operation at 150 F permitted intermittently.

• **Packings**—For good packing life, hydraulic system temperatures should be held to a practical minimum. This is especially important when leather packings are used.

Vegetable tanning produces leather which can be used to 160 F. Operation above this will cause charring and subsequent breakdown of the packing. Chrome tanning yields leathers which are limited to 200 F. There are also "retanned" leathers which are produced by a chrome tan followed by a vegetable "retan". These may be used for intervals of 15 minutes at 225 F. When these are wax filled there is the danger of the wax melting at higher temperatures, and Table II indicates

TABLE I Temperature Ranges for Viscosities of 4000 to 70 SSU for Six Synthetic Fluids

Viscosity—SSU @ 100 F	Minimum Start-up Temperature—°F	Maximum Operating Temperature—°F
90	10	117
150	32	136
220	41	149
300	50	160
550	67	178
1000	78	192

TABLE II Characteristics of Wax Filled Leather Packings

		Hard Wax Filled	Medium Wax Filled	Soft Wax Filled
Water Service	Melting Point °F	175	170	120
	Pressure Range	over 500 psi	300 to 500 psi	under 300 psi
Oil Service	Melting Point °F	180	175	150
	Pressure Range	over 1000 psi	100 to 1000 psi	under 100 psi

TABLE III Recommended Maximum Temperatures for Packing Materials

Material	Temperature—°F
Neoprene	250
GR-S	250
Buna-N	275
Butyl	212
Polyacrylic	300
Thiokol	170
Silicone	550
Teflon	550*
Leather	180
Cotton cloth-rubber	350
Asbestos cloth-rubber	450
Asbestos-rubber sheet packing	850

*Teflon begins to emit toxic fumes at temperatures as low as 400 F.

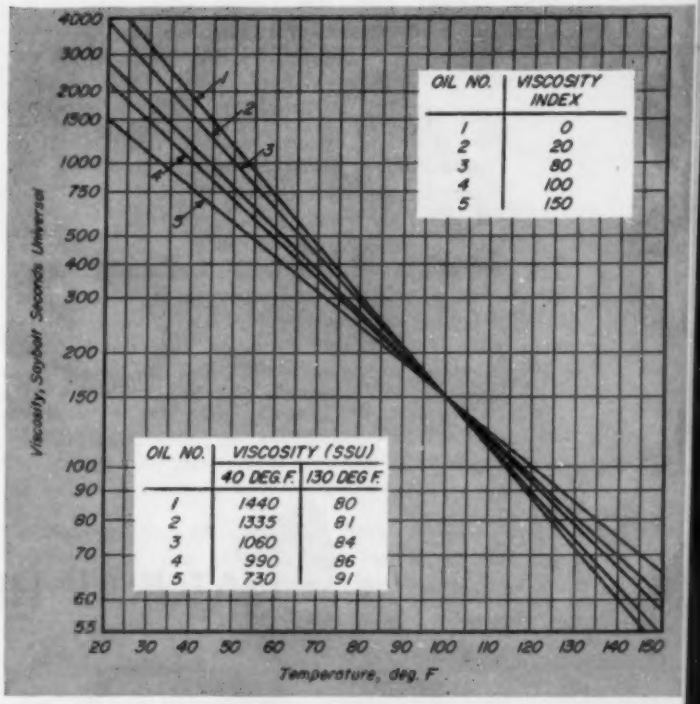

Viscosity, Saybolt Seconds Universal
Temperature, deg. F
OIL NO. | VISCOSITY INDEX
1 | 0
2 | 20
3 | 80
4 | 100
5 | 150
OIL NO. | VISCOSITY (SSU) 40 DEG F. | 130 DEG F.
1 | 1440 | 80
2 | 1335 | 81
3 | 1060 | 84
4 | 990 | 86
5 | 730 | 91

FIG. 5. VISCOSITY is a direct function of temperature. Maximum viscosity for operation of hydraulic equipment is usually given as 4000 SSU. Minimum viscosity is usually 70 SSU.

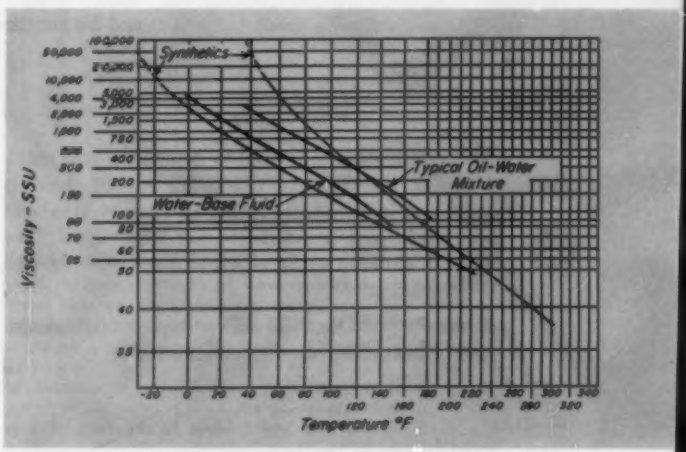


FIG. 6. VISCOSITY TEMPERATURE CHARACTERISTICS of fire-resistant fluids show that water-base and emulsion types follow similar curves. Synthetics can be tailored to higher or lower ranges depending on ultimate use.

permissable operating temperatures for leather packings in different systems. Thiokol impregnated leather packings with a mineral tan are recommended for service from —65 to 200 F at 10,000 psi.

With rubber packings, either homogenous or reinforced with fabric materials, higher temperatures result in aging which causes hardening of the rubber. Rubber also takes a permanent set at higher temperatures. Since most seal elements are installed with some initial preload depending on the nature of the seal, any loss in this preload be-

cause of a permanent set can cause leakage. In the general line of molded packings, the material or combination of materials usually determines the maximum temperature limit. Table III lists these values for the most common materials.

Thermoplastic materials such as Teflon become soft at elevated temperatures and usually fail because of cold flow and extrusion. Here again compounding aids considerably, and Teflon reinforced with asbestos, glass fibers or other materials has increased resistance to cold flow at elevated temperatures.

These are the results of a test on a machine having a 3-gallon hydraulic system and supplied by a 1½-gpm vane pump at 1000 psi. The machine was operated for 1000 hrs at 175 F and at 200 F to compare the effects on the oil.

	175 F Operation	200 F Operation
Viscosity Increase (SSU)	150 to 153	151 to 160
Neutralization Number Increase	.02 to .05	.01 to .65
Deposits	Light	Moderate
Average Vane Wear (%)	.15	.53

NATURAL HEAT DISSIPATION

Knowing before it is built how much heat a machine will dissipate can mean a saving in cost. If the designer is uncertain about the need for artificial cooling, he is often at a disadvantage because he must make some provision for items which may not be required at all.

TWO methods can be used to determine how much heat a machine can dissipate. One of these is analytical in which the machine surface area and heat transfer characteristics are considered. The other is by analogy in which curves are developed from tests.

• **Analytical Method**—The steps to be considered in heat dissipation calculations are:

a. Heat transfer from the housing of machine, to the surrounding air.
b. Transfer of power losses in the form of heat to the circulating oil.
c. Dissipation of heat from pipes and oil reservoirs to the surrounding air and to cooling water, if this is required.

The amount of heat loss in the machine can be determined from the formula:

$$H_1 = \frac{2545\ Q P\ (1-E)}{1714} \qquad (2)$$

where: H_1 = Heat loss in BTU/hr
Q = Flow in gpm
P = Pressure in psi
E = Efficiency of the machine

A large part of the energy loss is imparted to the air surrounding the machine and a formula which determines this transfer with reasonable accuracy is:

$$H_2 = 1.37\ KV^{0.6}\ A^{0.8}\ \Delta T \qquad (3)$$

where H_2 = Heat transferred in BTU/hr
ΔT = Temperature difference between the oil in the housing and the air surrounding the housing—°F.
A = Surface area of the housing in contact with the air—sq. ft.
V = Velocity of the air surrounding the housing—ft./hr.
K = Heat transfer coefficient from metal to air—BTU/hr. sq. ft. °F.

Values of K are given in Table IV. For practical purposes in this formula these values are the same as the termal conductivity of air.

The size of the housing affects the heat transfer. Small housings have slightly better characteristics than large housings. This has been determined by tests on spheres in wind tunnel installations.

The air velocity which also affects the heat transfer, is often difficult to determine. Under normal conditions inside of shops, usually no apparent motion of the air is noticeable. In this case the air

heated by the surface of the housing slowly rises to the ceiling of the building and is replaced by cool air from the floor. The velocity for this type of air circulation can be taken as 5000 ft./hr. When air circulation is aided by motors, flywheels, and other rotating equipment which is in the vicinity

TABLE IV Heat Transfer Coefficient From Metal Housings to Air.

Temperature—°F	K
32	.014
70	.015
212	.183

of the hydraulic equipment, the air velocity may be assumed to be approximately 30,000 ft./hr.

If the calculations show that the heat dissipating capacity, H_2, equals or exceeds the amount of heat generated, H_1, no futher investigations are necessary. If this is not the case, the surplus heat has to be dissipated. Sometimes it may be dissipated to the air from the pipes, valves, and oil reservoir. The same formula applies to these components although the individual units cannot be lumped into one total because of their different sizes which affect their heat dissipation capacity. Also the oil temperature in these units is somewhat lower than it is in the pump.

Calculating the dissipating capacity of a machine can have certain disadvantages if an attempt is made to be very accurate. Complications arise involving proper allowance for radiation, conduction, and convection of the various types of materials, wall thicknesses, color and thickness of paint, and position of the surfaces. For instance the heat dissipation from the bottom of an oil reservoir which is several inches above the floor and which has uncertain ventilation, is difficult to calculate.

• **Analogy Method**—In determining dissipation by analogy, the conditions of the new machine are compared to those of other machines of known characteristics. In one method which has been developed, the heat transfer area of the new machine is calculated and the oil circulation conditions compared to the known machine. The data is applied to curves to estimate heat dissipation rate.

One unit selected as a standard of active oil circulation has been a hydrostatic transmission containing a radial piston pump and motor, and an auxiliary gear pump. The 8-gpm auxiliary pump forces oil through the reservoir which has a capacity of 4 gallons. This means that the entire reservoir volume circulates every 30 seconds, and this is termed a 30-second interchange on the heat dissipation curve of Figure 7.

As a standard unit having moderate oil circulation, a radial piston pump containing an integral gear pump and mounted on a 22-gallon reservoir has been selected. Because the auxiliary pump had a capacity of 7½ gpm, the oil volume was circulated every 3 minutes, and this was termed a 3-minute interchange.

By using dynamometers the generated heat was determined by the difference in horsepower between the input and output shafts of the hydrostatic transmission, and by the input to the pump which was discharged through an adjustable relief valve, so that the entire input was converted to heat.

Figure 7 shows the results of these tests, and represents the number of square feet of external surface necessary to dissipate one horsepower of heat energy at various oil temperatures. While these curves were developed with one configuration of equipment, with good judgement, they can also be applied with good results to many other shapes of hydraulic units.

• **Determining Dissipation**—Pipes and valves having an oil flow of about 5 ft./sec. or greater should have their external surface areas determined

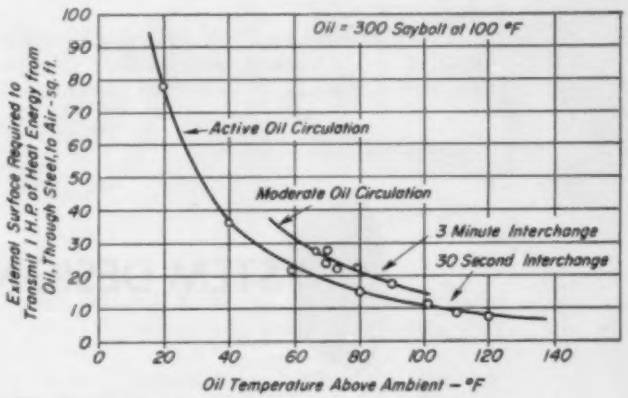


FIG. 7. HEAT TRANSFER AREA required to dissipate various amounts of heat energy are determined from this graph which was developed from tests on standard power units representing active and moderate oil circulation. Viscosity of the oil is 300 SSU at 100 F.

and added under active oil circulation units. Pumps and reservoirs should have their external areas determined and added under moderate oil circulation units with notations regarding the interchange rates and effectiveness of the baffling system in forcing circulation throughout the reservoir.

After the two total areas have been computed, they should be compared to determine where the proper curve will be located on Figure 7. The line for the machine in question will be parallel to the other two lines, but its location will be raised or lowered by the degree of oil circulation. The curve will usually fall between the two lines on Figure 7. If there should be considerable area in the reser-

voir having poor oil circulation, the curve may be quite high.

The number of square feet of surface area required to dissipate one horsepower of heat for various oil temperatures can be determined, and it then remains to determine how much heat there is to be dissipated before the operating temperature can be determined.

• **Component Surface Areas**—In determining the surface area of components some considerations must be kept in mind. Hydraulic cylinders vary considerably in their heat dissipation characteristics. Some cylinders move slowly and do not expel much oil to the reservoir. An example of this is the steering gear on a ship. The cylinders are nondifferential and the oil passes from one cylinder, through the pump to the other cylinder, and back. Even though the motion is almost continuous, the speed is so slow that the cylinders remain quite cool. In this case the cylinders and most of the piping must be excluded as a heat dissipating surface.

In contrast some press cylinders use surge valves in which a new batch of oil is received from the reservoir each stroke. In such cases the press cylinder can be included with an estimate as to how effective it will be as a heat dissipator.

A rotary hydraulic motor that runs at an appreciable speed should ordinarily be considered as an active oil circulator. Other parts of the machine such as beds, columns, frames, cross rails, and electric motors should not be included. Also bumps and projections of metal such as control handles, control rods, filler pipes, etc. do not count unless they are close to an area of active oil circulation. The main problem in moderate oil circulation areas is in getting the heat from the oil to the metal, so if there is active oil circulation near enough to the surface irregularities so the heat actually reaches the surfaces, the irregularities can be counted. However if the surface irregularities are near only moderate oil circulation, they will not materially affect the oil temperature. The moderate oil circulation curve automatically includes an average amount of irregularities, because although the test unit did have projections, it was assumed to be a box.

The bottom of the reservoir was included for both curves of Figure 7, even though the circulation on the bottom was poor. It was felt that the oil circulation on the bottom was very significant, so that the designer must include the bottom of reservoirs to get comparable figures for using the curves.

SYSTEM DESIGN TO REDUCE HEATING

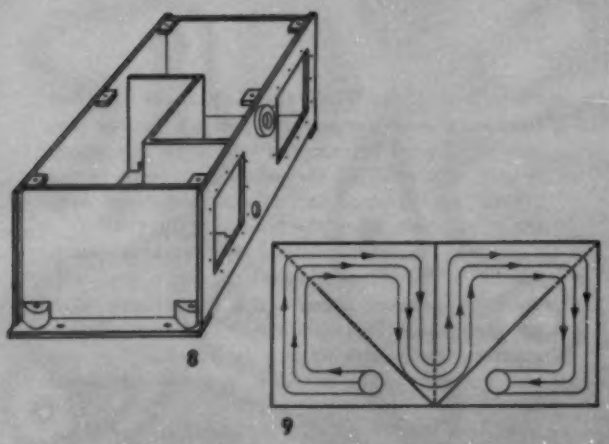
One of the primary objectives in designing hydraulic equipment is to provide for natural cooling. Here are ideas for mounting the pump, designing the reservoir, and laying out the circuit that can result in the most economical machine.

THE reservoir offers one of the best units for designing natural cooling into a machine, and where the size is not limited, the reservoir should have a volume as least three times the pump capacity. JIC Standards require that the reservoir have a volume sufficient to contain all of the fluid that will drain from the system back into the tank by gravity flow; maintain the fluid level within a reasonable working height during the operating cycle; dissipate the heat generated by normal operation of the equipment; and allow air and foreign matter to separate out of the fluid.

Duty cycle is an important factor in sizing the reservoir. If oil is forced over the relief valve during a part of the cycle, the time during which this occurs is important in comparison to the time the pump is unloaded or is pumping at normal operating pressure.

In addition to size, the arrangement of baffles is important in designing a reservoir. Although JIC Standards require some means between the pump intake and the system return to facilitate settling out foreign matter, there is no recognition in the Standards of the heat dissipating capabilities of baffles.

The reservoir baffles direct flow from the sys-



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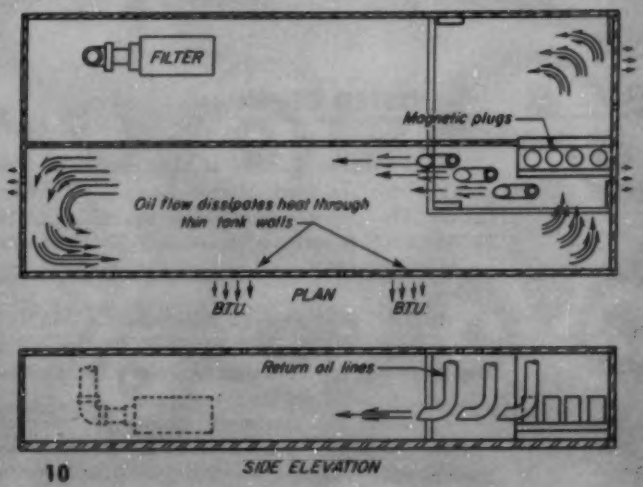

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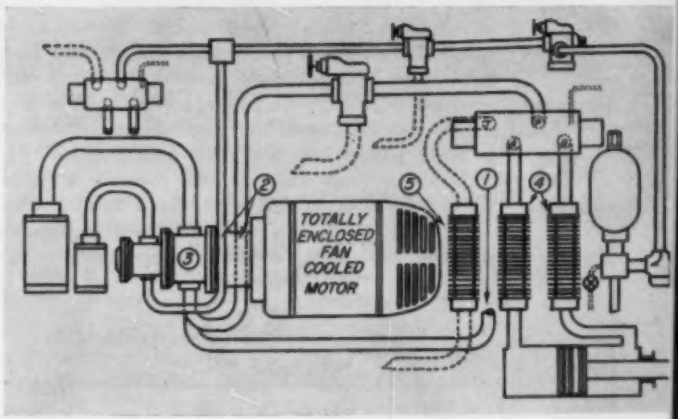
FIG. 8. SYMMETRICAL DESIGN of this baffling arrangement permits interchanging pump and motor mounted on top of the reservoir.

FIG. 9. THIS BAFFLE DESIGN is recommended for reservoirs of 10-gallon capacity and larger. Baffles direct oil around tank periphery where heat transfer takes place.

FIG. 10. RESERVOIR WITH THIS BAFFLING is constructed as low as possible to take advantage of cooling at floor level. Fluid makes 180-degree turn and is directed back over magnetic plugs.

FIG. 11. FIVE METHODS OF COOLING hydraulic fluid by making use of the air moved by the electric motor. Fins are mounted on the tubing and located in the air stream. Photo shows the installation and also illustrates a low reservoir with a valve chamber in which most of the valves and tubing are mounted.



tem return to the pump intake, so the objective for best cooling is baffling which gives the longest possible path. Not only does this increase the cooling, but it also promotes demulsification of the oil, and assists in settling out contaminants.

Many reservoirs have a baffle installed lengthwise in the reservoir with the intake and return on each side at one end. This forces the fluid to circulate around almost the full periphery of the tank. Another arrangement is shown in Figure 8.

Another design for baffling is shown in Figure 9. This is for reservoirs of 10 gallons and larger.

Figure 10 shows a third baffling design. Return flow enters from the horizontal submerged tubes and is directed along the tank perimeter. The fluid makes a 180-degree turn at the left end and is directed back over the magnetic plugs to the intake. In this tank design ¼-inch thick steel plate walls are used wherever possible. To carry the overhead load, external, 6 x ½-inch pilasters are used. Because heat transfer is greatest at floor level where the air is coolest the tank is as flat as possible.

• **Fin Cooling**—The electric motor driving the pump can be used for cooling, especially if a totally enclosed, fan-cooled motor is used. Table V shows the amount of air moved by various sizes of motors.

Figure 11 indicates five methods for mounting two pumps to take advantage of the cooling air moved by the motor.

In method 1, fins are installed on the pump output tubing and located in the air intake to the electric motor. This gives the maximum heat dissipation by using motor cooling air and is advisable for equipment where over 10,000 BTU/hr. is generated. This type of cooling is particularly good where there is a considerable amount of absorbed air in the fluid. The adiabatic compression of this absorbed air will result in a theoretical temperature in the range of 1000 F. Cooling the pump output helps suppress this temperature immediately and increases the fluid life.

Method 2 is recommended where the heat generated is less than 8000 BTU/hr. With the pumps directly mounted to the motor, the pump output tubing is bent in a U-shape, so that air discharged from the motor flows over the tubing. In addition to cooling the discharge fluid, the pumps themselves are cooled by the air discharged from the motor.

SYSTEM DESIGN

When cylinder demand is high enough and the tubing runs are short, Method 4 can be used effectively. The fins are installed on the tubing to the cylinder. This method should not be used when a small oil volume makes a partial shuttle in long tubing.

Method 5 is effective in installations where there is a long unload and load time. It requires an open center, spring centered valve. The circulating oil is cooled during the idle time.

To obtain the maximum cooling by using the motor air flow, it is essential to use thin wall steel tubing and to eliminate fittings which have restrictions.

• **Circuit Design**—Many circuits are available for minimizing the power requirements and heat generation in a hydraulic system. One important principle is to have the pump supply only the fluid required by the system, and to minimize the amount of fluid passed over the relief valve.

In applications where a high pressure must be applied for a large part of the cycle and flow requirements are low, a booster should be considered. This permits the pump to operate at much lower pressures. When the booster is supplied from a pressure compensated pump, a further savings is effected because the output of this pump is only that required to maintain pressure in the system, and none of the volume is dumped over the relief valve when the booster stalls.

Another common method for limiting pump volume is the hi-lo circuit which uses a high volume, low pressure pump and a low volume, high pressure pump. This circuit may be connected with separate components or may be purchased in one unit complete with valves. It is especially useful on applications where a rapid traverse is followed by a high force feed or clamp. Both pumps supply fluid during rapid traverse. When the higher pressure is developed, the large volume pump is unloaded, and the small volume supplies the system requirements. One advantage of this circuit over a pressure compensated pump for certain applications is the fast action of the volume change and the fact that the small volume pump working at full capacity may be more efficient than a large volume pump working at partial capacity. Internal leakage of any pump is proportional to its size and operating pressure.

• **Plumbing Design**—Using the common rule of thumb that fluid velocity in hydraulic lines should not exceed 15 fps can lead to a design which promotes heating. In sizing the ID of the lines, the important consideration is to obtain laminar flow in which fluid friction and consequently heating are a minimum. Laminar flow depends not only on the fluid velocity, but also on the ID of the line, the fluid density, and the fluid viscosity. Whether flow is laminar or turbulent is indicated by the Reynolds Number which is computed from the formula:

$$R = \frac{Vd\rho}{\mu}$$

where V = Average fluid velocity (fps)
d = Line ID (ft.)
ρ = fluid density (lb./cu. ft.)
μ = fluid viscosity (lb./sec - ft.)

For Reynolds Numbers less than 2000, the flow can be safely considered to be laminar.

This formula can be used in selecting lines plotting flow vs. velocity for various sizes of tubes, and determining velocities for laminar flow based on a Reynolds Number of 2000 and the density and viscosity of the oil. This is shown by the curves of Figure 12 in which points to the left of the hyperbolic curves will give laminar flow when using the particular oil at the given temperature.

Many other factors must be kept in mind when laying out and piping up the system. Tube bends should be kept as long as possible. Fittings should be selected for their ability to pass flow freely with a minimum of pressure drop and friction. Valves should be sized to pass maximum flow without excessive restrictions, and cylinder ports should be large enough so that they do not constitute a potential "hot spot."

TABLE V Air Flow In Totally Enclosed Fan Cooled Motors

Motor Size-Hp	Air Flow—Cfm
7½	1000
10	1500
15	1500
20	1750
25	2000
30	2500
40	2500
50	2500

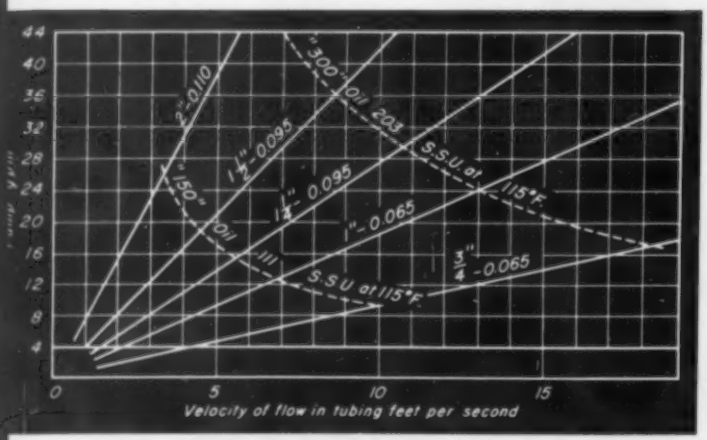


FIG. 12. PIPE SELECTION FOR LAMINAR FLOW is simplified by drawing a graph such as this. Dashed lines connect velocity points on each curve at which Reynolds Number is less than 2000.

OIL COOLERS

Although the theory of oil coolers can become quite involved, selection of a suitable unit is simplified by the use of curves and standard formulas. In selecting an oil cooler where many units are involved, frequently the practice is to specify the oil cooler after testing several to determine the most economical one. Where only one or two units are required, the practice is usually to provide a margin of safety in selecting the oil cooler.

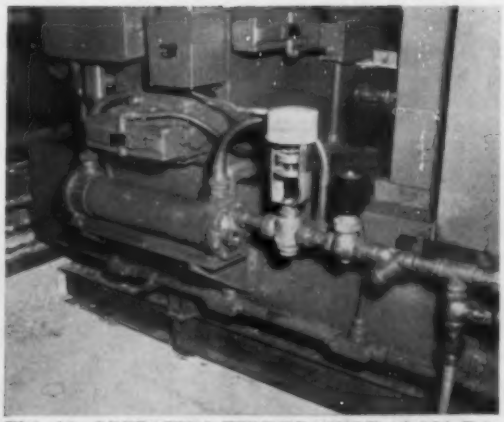


FIG. 13. OPERATING TEMPERATURE of 120 F is maintained by this oil cooler and water control valves.

FORCED convection cooling of hydraulic fluid can be accomplished either by a central cooling system or an individual oil cooler mounted with the machine. In the two types of central systems, the oil is either cooled directly in a central cooling unit or there is a central system for cooling water with an individual system for cooling the oil.

• **Central Cooling Systems**—Several types of equipment can be used for the central cooling system. The evaporative cooler consists of a coil section through which the oil circulates. Water is sprayed over this coil and air is blown up from the bottom. In passing through the air, part of the water evaporates cooling the remaining water.

The dry air type cooler consists of a core of finned tubes over which air is blown. This type cannot economically cool the fluid to within less than 8 to 10 degrees of the air temperature, and it is most suitable where the maximum oil temperature does not have to be below 130 F with an ambient air temperature of 100 F.

A third type of central system cooling equipment is the shell and tube oil cooler. This represents the least first cost with the highest operating cost. The low temperature to which the oil can be cooled, and the compactness of the equipment, make this type very attractive.

• **Individual Oil Coolers**—Types of oil coolers for individual installation are water-to-oil or air-to-oil units. Water-to-oil types are shell and tube, plate, and inner fin.

The shell and tube units, using water as the cooling medium; are the most common because of their compactness, relative low cost, standardization and reliability. They consist of a shell which encloses a bundle of tubes. Baffles which hold these tubes in place direct the flow of oil as it passes through the shell side of the exchanger at right angles to the tube bundle. Water connections are provided to the tubes.

Pressure drop through the shell side of the exchanger is often important and should usually be limited to 10 to 15 psi. This pressure drop depends on the length of the exchanger, velocity of the oil, tube size and spacing, and baffle spacing and cut.

The performance of a shell and tube heat exchanger is determined by the area or surface in the exchanger. Other factors which affect the performance are the baffle spacing, tube spacing, tube diameter, and the clearances between baffles and tubes and baffles and shell.

In single-pass coolers, the water flows directly through the unit from one end to the other. In 2-pass units the water enters and leaves the exchanger at the same end, and the opposite end is constructed to force a 180-degree turn in water flow. 4-pass coolers are also available.

The criterion for pass arrangement is the quantity of cooling water available and the approach of the oil temperature to the water temperature. In most systems the difference between the oil and water temperatures is great enough so that a multi-pass cooler can be used. However, in applications where the entering water temperature approaches the entering oil temperature by 10 degrees or less, a multi-pass cooler would require excessive surface or would not perform at all. A single pass cooler would transfer the heat satisfactorily.

Because of corrosion, the cooler must be made from aluminum, a copper base alloy, or a stainless steel. Most coolers are made from copper base alloys even though this is not in accordance with JIC Standards. However they have been widely accepted because of their low cost compared to coolers of stainless steel. Aluminum coolers are not easily fabricated and are difficult to maintain.

OIL COOLERS

• **Air Coolers**—Where water is not readily available or is too expensive for cooling, air coolers are used. These are also effective where space heating is required or on mobile equipment where water connections cannot be made. The air cooler is essentially a finned tube surface with a fan for forcing air over the fins. Oil is pumped through the tubes which contain turbulators to increase the turbulence of the oil and promote cooling. The air cooler is suitable for applications where regulated oil temperature exceeds air temperature by more than 10 degrees.

• **Cooler Selection**—Selection of a shell and tube oil cooler depends upon the heat transfer load, required surface, and velocities of oil and water.

One manufacturer has simplified the procedure by providing curves, such as those shown in Figure 16, so that the cooler can be selected when the oil flow and heat transfer load are known. These curves are based on an entering water temperature of 85 F and a reservoir temperature of 125 F. For water temperatures different than this, the correction factors shown on the graphs should be used as indicated in the note. The ratios of 1:1 or 2:1 above each curve indicate the ratios of oil to water flow. Thus a ratio of 1:1 indicates that for each gallon of oil circulated, a minimum of 1 gallon of water must be circulated to obtain the capacity shown on the curve.

As an example, suppose the oil flow is 40 gpm and it is necessary to remove 6 hp with the oil cooler. The entering water temperature is 95 F. As indicated by the table of correction factors, the

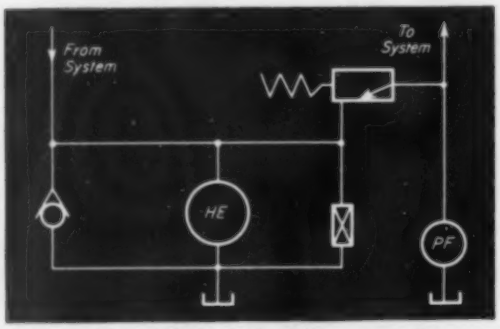


FIG. 14. ON SMALL SYSTEMS a generally satisfactory arrangement for the oil cooler is in the return line and the drain connection of the relief valve. For intermediate size systems, the globe valve by-passes some of the return flow. The check valve provides protection against surges.

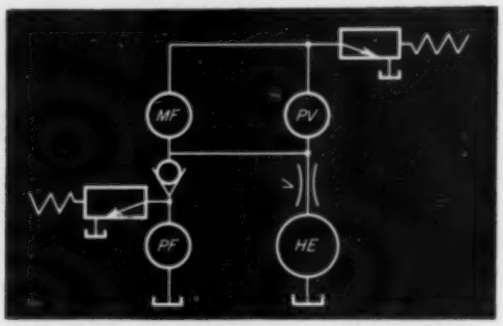


FIG. 15. COOLING A CLOSED SYSTEM hydrostatic transmission circuit is accomplished by this circuit in which the hydraulic motor rotates in one direction only. Fluid is supplied at 300 psi to supercharge the variable displacement pump. Part of this fluid is metered through the oil cooler.

FIG. 16. OIL COOLERS CAN BE SELECTED by referring to curves such as these supplied by one manufacturer. Capacities are based on a reservoir oil temperature of 125 F.

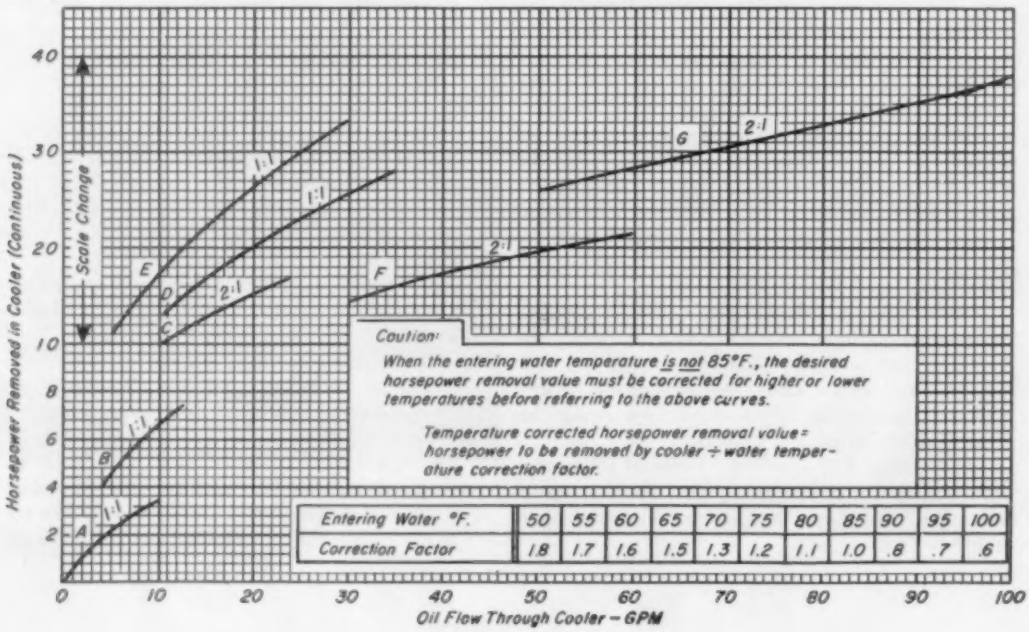

Horsepower Removed in Cooler (Continuous)
Scale Change
40
30
20
10
8
6
4
2
A
B
C
D
E
F
G
1:1
2:1
Caution:
When the entering water temperature is not 85°F., the desired horsepower removal value must be corrected for higher or lower temperatures before referring to the above curves.
Temperature corrected horsepower removal value = horsepower to be removed by cooler ÷ water temperature correction factor.
Entering Water °F. 50 55 60 65 70 75 80 85 90 95 100
Correction Factor 1.8 1.7 1.6 1.5 1.3 1.2 1.1 1.0 .8 .7 .6
0 10 20 30 40 50 60 70 80 90 100
Oil Flow Through Cooler – GPM

Table VI—Logarithmic Mean Temperature Difference Factors.

STD ÷ LTD	LMTD ÷ LTD	STD ÷ LTD	LMTD ÷ LTD	STD ÷ LTD	LMTD ÷ LTD	STD ÷ LTD	LMTD ÷ LTD
1	2	1	2	1	2	1	2
		0.25	0.541	0.50	0.721	0.75	0.870
0.01	0.215	.26	.549	.51	.728	.76	.874
.02	.251	.27	.558	.52	.734	.77	.879
.03	.277	.28	.566	.53	.740	.78	.886
.04	.298	.29	.574	.54	.746	.79	.890
0.05	0.317	0.30	0.582	0.55	0.753	0.80	0.896
.06	.334	.31	.589	.56	.759	.81	.902
.07	.350	.32	.597	.57	.765	.82	.907
.08	.364	.33	.604	.58	.771	.83	.913
.09	.378	.34	.612	.59	.777	.84	.918
0.10	0.391	0.35	0.619	0.60	0.783	0.85	0.923
.11	.403	.36	.626	.61	.789	.86	.928
.12	.415	.37	.634	.62	.795	.87	.934
.13	.427	.38	.641	.63	.801	.88	.939
.14	.438	.39	.648	.64	.806	.89	.944
0.15	0.448	0.40	0.655	0.65	0.813	0.90	0.949
.16	.458	.41	.662	.66	.818	.91	.955
.17	.469	.42	.669	.67	.823	.92	.959
.18	.478	.43	.675	.68	.829	.93	.964
.19	.488	.44	.682	.69	.836	.94	.970
0.20	0.497	0.45	0.689	0.70	0.840	0.95	0.975
.21	.506	.46	.695	.71	.848	.96	.979
.22	.515	.47	.702	.72	.852	.97	.986
.23	.524	.48	.709	.73	.858	.98	.991
.24	.533	.49	.715	.74	.864	.99	.995

Table VII—Correction Factors for Multi-pass Oil Coolers.

R \ K	.05	.1	.15	.2	.25	.3	.35	.4	.45	.5	.6	.7	.8	.9	.10
.2								.999	.993	.984	.972	.942	.908	.845	.71
.4							.994	.983	.971	.959	.922	.855	.70		
.6						.992	.980	.965	.948	.923	.840				
.8					.995	.981	.965	.945	.916	.872					
1.0					.988	.970	.949	.918	.867	.770					
2.0			.997	.973	.940	.845	.740								
3.0			.977	.933	.835										
4.0		.993	.950	.850											
5.0		.982	.917												
6.0		.968	.855												
8.0		.930													
10.0	.996	.880													
12.0	.983	.780													
14.0	.972														
16.0	.958														
18.0	.940														
20.0	.913														

Use of 2 or 4 exchangers should be checked by factory when K & R fall in this region.

capacity of a cooler with 95 F water is only .7 of what it would be with 85 F water, so the 6 hp is divided by .7 to obtain 8.5 hp. The intersection of 40 gpm and 8.5 is located. Model F would handle these requirements. Model C would also remove the 8.5 hp, but would not handle 40 gpm. A solution is to bypass part of the fluid around the cooler so that the smaller Model C cooler can be used.

The actual area required in the cooler can be computed from the general heat transfer equation:

$$Q = UA\ (LMTD) \quad \text{.....(5)}$$

where Q = Heat load BTU/hr
U = Over-all heat transfer coefficient - BTU/hr ft² °f
A = Surface area - ft²
LMTD = Logarithmic mean temperature difference

The temperature change of the water and oil is:

$$\Delta t = \frac{Q}{GPM \times 500} \quad \text{(for water .....(6)}$$

$$\Delta T = \frac{Q}{GPM \times 210} \quad \text{(for oil) .....(7)}$$

The formula takes into account the average specific heat of hydraulic oil.

Values of U can be taken as 275 for water with a temperature between 80 and 180 F, and 85 for oil with an average viscosity of 200 SSU.

The LMTD can be obtained from the formula:

$$LMTD = \frac{T_L - T_S}{\log_e \frac{T_L}{T_S}} \quad \text{.....(8)}$$

Where T_L and T_S are the temperature differences between the oil and water at the ends of the cooler in a single pass unit.

Table VI can be used to simplify the calculation of LMTD. For a single pass cooler, the entering water temperature, t_1, is subtracted from the leaving oil temperature, T_2, to obtain the large temperature difference, LTD. The leaving water temperature, t_2, is subtracted from the entering oil temperature, T_1, to obtain the small temperature difference, STD. By dividing the LTD into the STD and finding the corresponding value of LMTD divided by LTD, the LMTD can be computed.

If a 2 or 4-pass exchanger is used, the K and R factors must be computed from the formulas:

$$K = \frac{t_2 - t_1}{T_1 - t_1} \quad \text{.....(9)}$$

$$R = \frac{T_1 - T_2}{t_2 - t_1} \quad \text{.....(10)}$$

Using these factors, a correction factor is obtained from Table VII and LMTD is multiplied by this factor. Then using equation 5, the approximate surface area can be found and an oil cooler selected which has as much or more surface. Baffle spacing and pass arrangement are then selected, so that the velocities of water and oil are between 1 and 6 ft/sec.

Although it is generally true that the colder the water supplied, the more heat that can be removed from the oil, a point can be reached where the water is actually too cold for efficient operation. Oil has a tendency to form a layer on cold surfaces and to insulate the surface. The colder the surface, the thicker the layer of oil, a 1-inch layer of non-circulating oil is just as good an insulator as a ¼-inch layer of fibrous rock wool insulation used in building construction. Sometimes efficiency is increased by decreasing water flow and raising the outlet water temperature.

IMMERSION HEATERS

Keeping the fluid temperature down is not the only factor in temperature control of hydraulic systems. In some steel mills and other heavy industrial plants, temperatures drop so low that the fluid must be pre-heated before start up of the machine to insure a viscosity within the maximum limit.

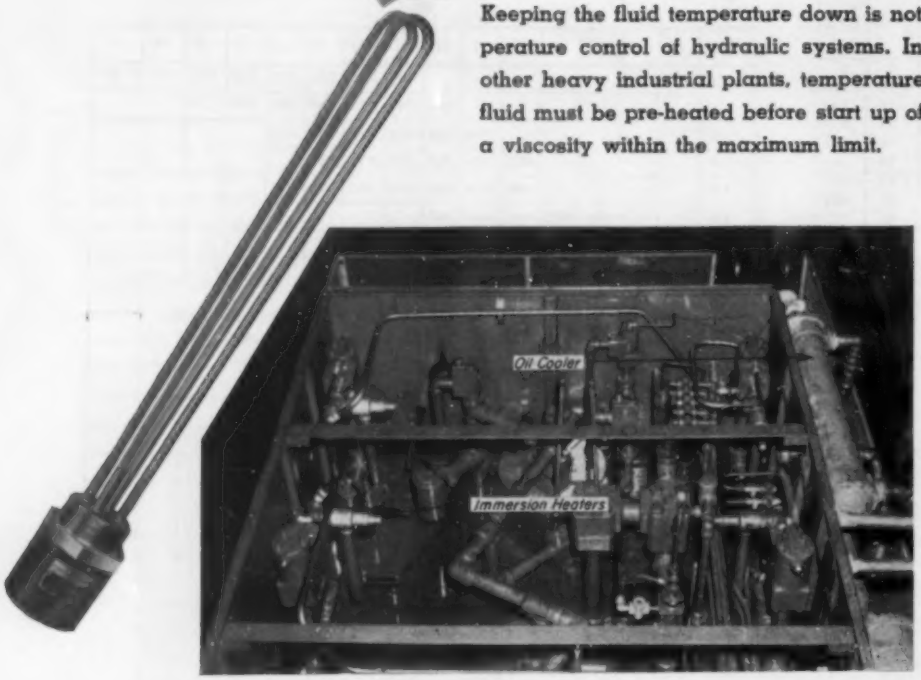


FIG. 17. IMMERSION HEATERS IN A PRESS RESERVOIR are connected in 3-phase for most efficient operation. Heaters should be installed as low in the tank as possible and can be bent if necessary to avoid interference with piping and valves.

THE accepted method of pre-heating hydraulic fluid is by the use of electric immersion heaters installed in the reservoir. These are constructed from a helical coil of nickel chromium resistance wire embedded in refractory material and enclosed in a metal case. Connections are brought out to terminals.

The immersion heaters are rated in kilowatts and are specified on the basis of the amount of fluid to be heated.

$$KW = \frac{WsT}{3412\,t} \qquad \text{.....(11)}$$

where: W = Weight of fluid — lb.
s = Specific heat of the fluid — BTU/lb. °F
T = Temperature rise — °F
t = Heat up time — 2 hours

In calculating the heat losses through the sides of the reservoir, a loss of 5 watts per sq. ft. at 70 F is assumed.

A general rule of thumb for estimating immersion heaters is that 1 KW will heat 100 gallons of oil 10 degrees in 1 hour.

In addition to selecting the heating capacity of the immersion units, the watt-density or amount of heat generated per square inch of heater surface area is an important consideration in preventing burning of the oil. The watt density should be limited to 20 watts/sq. in. for circulating oil and 15 watts/sq. in. for static oil. Watt densities higher than these cause a build-up of carbon on the heater. This decreases its heat transfer ability and eventually results in burnout of the heater and breakdown of the oil.

• **Heater Installation**—The heaters should be mounted as close to the bottom of the reservoir as possible leaving only enough room to prevent sludge from coming in contact with the unit. In some installations this may be difficult because of interference with valves and piping. One solution is to bend the immersion heaters to the required shape and then flange mount them so they can be easily removed.

In very large reservoirs, heating all the oil would be expensive and time consuming. If the heater can be located near the pump inlet, local heating may be sufficient to permit machine start-up.

The thermostats controlling the heaters should be mounted away from any large input port at a height of ½ to ⅔ of the total tank height. They should be as far as possible from the heaters.

One circuit arrangement for connecting heaters and control is shown in Figure 18. With the power disconnect closed, the heaters are energized when the HEAT ON-OFF switch is set to ON. When the oil temperature reaches 70 F, thermostat 1 is actuated de-energizing the contactor and the heating elements. Thermostat 2 prevents the oil from overheating. When this opens above the maximum allowable temperature, the cycling controls are de-

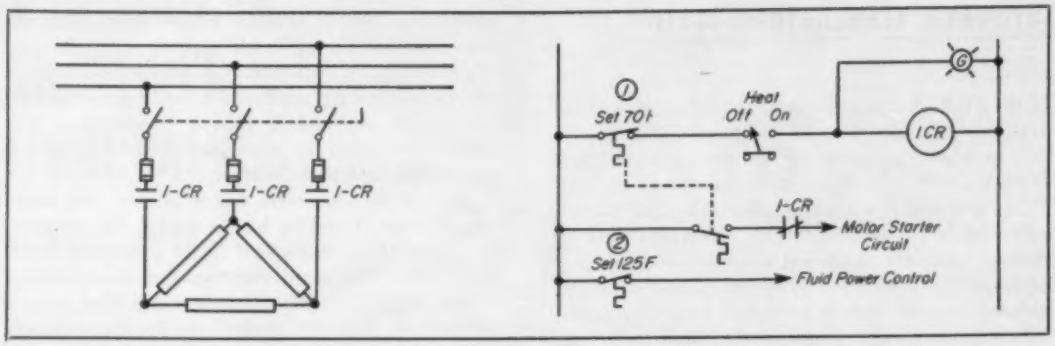


FIG. 18. COMMON IMMERSION HEATER CIRCUIT and control uses two thermostats to control heaters and machine electrical controls. At 70 F thermostat 1 operates to disconnect heaters and start pump motor. An overtemperature of 125 F opens thermostat 2 to stop the machine cycle.

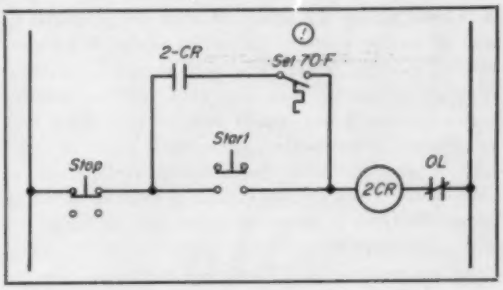


FIG. 19. CIRCUIT PERMITTING EMERGENCY OPERATION connects normally open contacts of low temperature thermostat in pump motor interlock circuit for start switch. Pump can be operated before temperature reaches 70 F by holding the START switch.

energized stopping the machine. The pump motor continues to run, so that oil circulates.

To allow the pump motor to be started in an emergency, the normally open contacts of thermostat 1 may be connected in the motor starter interlock circuit as shown in Figure 19. In this circuit, the motor will run as long as the start button is held depressed or until the oil temperature has reached 70 F.

In a large system such as a press having several large cylinder-ram assemblies where these components are distributed over a wide area, a relatively high percentage of the operating oil may be outside the reservoir. On starting such a system, the return oil can cool the oil in the heated tank. If a thermostat without a fairly wide differential of 15 to 20 degrees is not used, several attempts at starting may be made before the system continues to operate. This can be prevented by using thermostats having a built-in, adjustable differential or by using four thermostats, two are set at 70 F and the other two are set at 90 F.

AUTOMATIC TEMPERATURE CONTROL

Many industrial users of water do not realize that water is changing from a plentiful natural resource to a precious and expensive one. Automatic controls for cooling water can pay for themselves within a very short time.

TWO methods can be used to control flow of cooling water. In the on-off type of control, a 2-way solenoid valve installed in the water line to the oil cooler is actuated by a thermostat sensing oil temperature. One type of thermostat for this purpose is shown in Figure 20. The snap switch is actuated by the bellows plunger attached to the bellows. The bellows contains a temperature sensitive liquid which expands and extends the bellows with increasing temperature. The snap switch actuates the solenoid valve to allow water flow to the cooler. This control is usually wired in series with the machine switch, so that when the machine is shut down, cooling water is stopped.

The second method of controlling cooling water is by using a bellows-controlled modulating valve as shown in Figure 22. This valve also makes use of the principle of a fluid which expands when heated. The probe, connecting line, and bellows are filled with this fluid. The probe is installed in the fluid reservoir so that as the fluid heats up, the bellows extends to open the valve and pass more cooling water to the oil cooler. Installing the probe in a well mounted in the reservoir permits removal

of the probe for inspection or replacement without draining the fluid.

A combination unit for controlling water flow is shown in Figure 21. This includes a filter, solenoid valve and flow control valve. The flow control valve has a rubber diaphragm which is flexed by pressure into the machined grooves and hole of a brass orifice plate. One fixed rate of outlet flow is assured because flow is regulated according to the inlet pressures exerted against the diaphragm.

• **Conserving Cooling Water**—One excellent way of saving costs in industrial plants is by conserving cooling water. The cost of water distribution is increasing steadily, even with a nearby water source. Water supply may be something that is assumed to be inexhaustible, until a city is faced with a shortage with the resulting restrictions or shut-down. Tests carried out in a plastics molding plant illustrate how much water can be saved by adequate control.

In an analysis of 23 molding machines, the uncontrolled flow was determined by meters and positive displacement methods. The water was originally controlled by manual valves which were seldom shut off during lunch periods, shift changes, or retooling. A satisfactory controlled flow rate was established by gradually throttling the cooling water with mechanical valves. Temperature was closely monitored by thermometers which were a part of the hydraulic system.

Because the tests were run in winter, and water temperatures would be higher during the summer, a margin of ⅓ was added to the controlled water rate. Table VIII shows the results of the tests.

The water control which was installed was a mechanical flow-rate control device that delivers one set rate of fluid flow regardless of varying pressures. This became the important water saver when water flow was required. In addition, solenoid controlled valves were installed to control the on and off flow of water. When wired in series with the main control switch of each machine, these valves became an important water saver by shutting off water flow when the machine was not in operation, and starting the flow when operation was resumed.

By computing the number of shifts operating, days of the week worked, and other governing factors, the results as near as could be determined were as shown in Table VIII. ▼▼▼

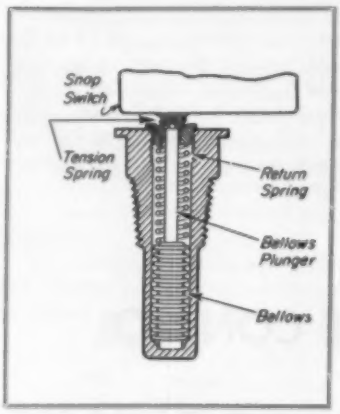


FIG. 20. THERMOSTAT controlling a solenoid valve in the cooling water line has a bellows containing an expandable fluid. Bellows actuates the snap switch through a plunger.

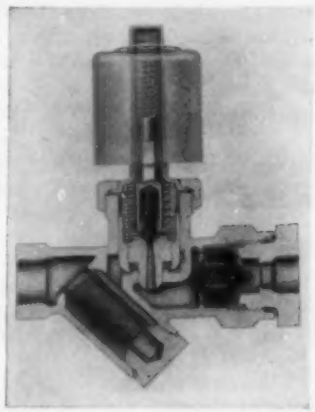


FIG. 21. SOLENOID VALVE, filter and flow control valve are combined in this unit for controlling cooling water. Flow control has a moving rubber diaphragm which seats against an orifice plate.

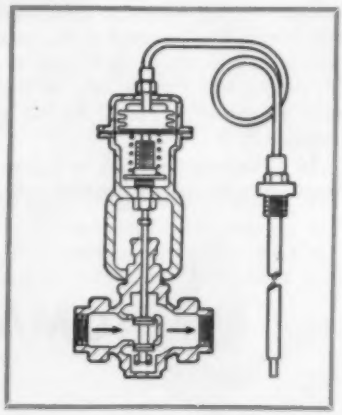


FIG. 22. MODULATING VALVE for controlling cooling water flow is a normally closed unit which opens as the reservoir oil heats up. Probe is installed in the reservoir; connecting line and bellows contain expandable fluid.

TABLE VIII—Water Savings by Applying Flow Controls

Machine Molding Capacity Oz.	Number of Machines Operating	Uncontrolled Flow Rate Per Machine G.P.M.	Controlled Flow Rate Per Machine G.P.M.	Weekly Conservation Per Machine Gal.	Total Weekly Conservation Gal.
4	1	3.9	1.0	29,232	29,232
8	10	3.9	1.0	38,137	381,744
12	3	4.1	1.0	31,248	93,744
16	4	8.9	4.0	49,392	197,568
28	1	8.9	4.0	49,392	49,392
32	1	8.9	4.0	49,392	49,392
60	3	8.9	4.0	72,818	218,454
				Total	1,019,152

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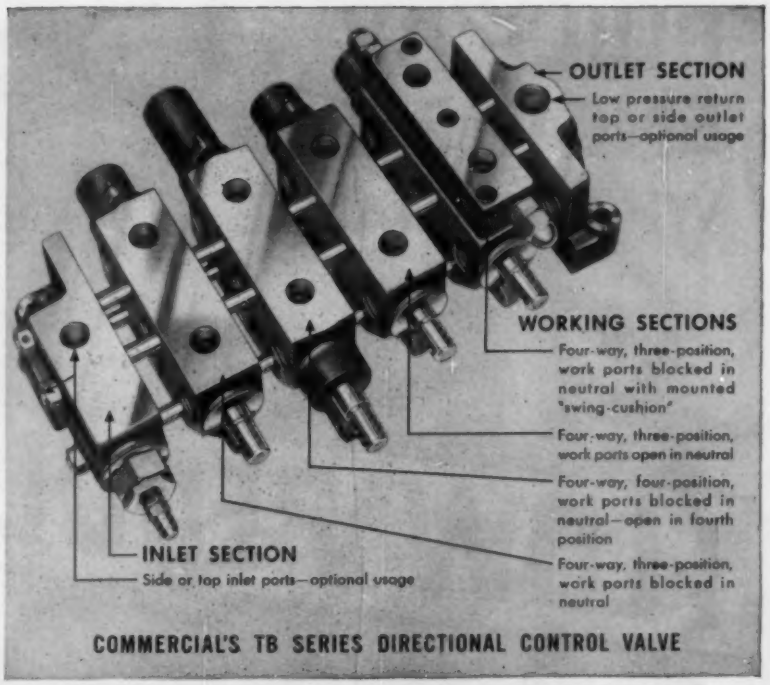
NEW DESIGN IN FLUID POWER CONTROL VALVES


OUTLET SECTION
Low pressure return top or side outlet ports—optional usage
WORKING SECTIONS
Four-way, three-position, work ports blocked in neutral with mounted "swing-cushion"
Four-way, three-position, work ports open in neutral
Four-way, four-position, work ports blocked in neutral—open in fourth position
Four-way, three-position, work ports blocked in neutral
INLET SECTION
Side or top inlet ports—optional usage
COMMERCIAL'S TB SERIES DIRECTIONAL CONTROL VALVE

Pressure Drop Reduced 15%

The higher the back pressure in a control valve the greater the power loss and the less efficient the fluid power system.

Advance design in Commercial's control valves—larger circulatory passageways, more uniform cross sections, smoother wall surfaces, and freedom from abrupt direction changes—lowers internal pressure drop as much as 15%.

Commercial valve performance is increased because flow around large outside surfaces of solid spools is unimpeded—not forced through constricting orifices. And Commercial's valve passageways have equal or greater cross-sectional area than inlet or work ports.

Load Drop Eliminated

Pressurized return flow in many conventional control valves frequently results in erratic operation—sudden movements and one load dropping while another is being positioned.

An individual check, located so as not to cause any passageway constriction, is built into every working section of a Commercial control valve. It blocks all pressurized return flow until it is overcome by pressure build-up from the pump—makes for safe, smooth, precise and accident-free operation.

2000 PSI Operation Perfected

Because of structural design weaknesses in many control valves optimum operation at pressures up to 2000 psi is often not practical or even possible.

With Commercial's control valves operation at pressures up to 2000 psi is recommended. The non-porous grain structure of the high-strength, semi-steel castings used in Commercial's valve sections prevents seepage of pressurized oil. And because of their greater strength the section castings do not distort when stressed under pressure.

The use of O-rings—instead of gaskets—for all sealing between sections and at the ends of spools assures leakproof operation. Elimination of gaskets between sections also precludes overstress and distortion of section castings to prevent possible leakage.

Overload Protection Built In

A combination overload relief-pressure valve—incorporated right in the housing of Commercial's control valves—provides positive safety protection for the fluid power system, plus overload protection for the structural members and tools of the machine in operation. Its complete cartridge construction permits easy removal from the inlet section of the valve bank—for quick inspection or replacement.

Rated on Performance

For the purpose of greater accuracy all Commercial control valves are rated on the basis of performance—not mere size of inlet and outlet ports alone. With Commercial's "performance-rated" control valves proper valve selection for any fluid power system is based on total pressure drop values when assembled in various combinations of actual operating actions.

Commercial's control valves involve parallel circuit operation—provide pressure to two or more operations simultaneously when so desired. Working sections having three-way, three-position; four-way, three-position; and four-way, four-position actions, are available and can be assembled independently in any combination or sequence.

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A hydraulic counterbalancing system for a 1-ton milling head permits raising and lowering the head during milling with a 3-hp motor at speeds of 40 to 80 ipm.

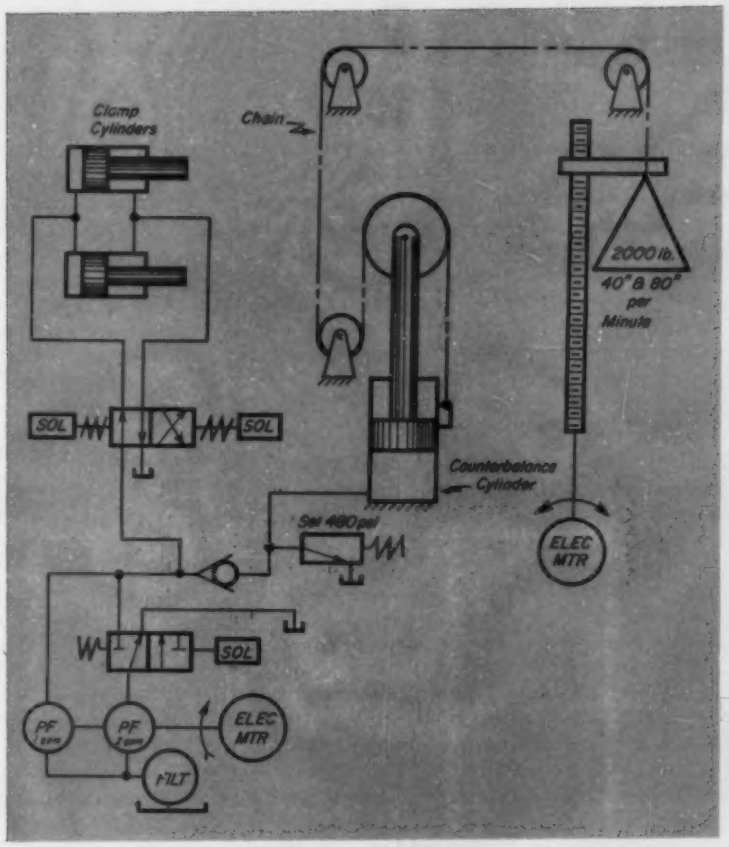

FIG. 1. COUNTERBALANCING CIRCUIT maintains 480-psi pressure on cylinder head end at all times. 2-gpm section of pump is unloaded during cylinder down-stroke and 1-gpm output and cylinder exhaust is dumped through relief valve. On cylinder up-stroke both sections of pump deliver to system and excess is dumped over relief.

COUNTERBALANCING CIRCUIT

...for an overhung milling cutter

● By Brad Bartlett and Ernest L. Kaiser

ALTHOUGH hydraulics is usually associated with such high force operations as pressing and tool feeding, characteristics of fluid under pressure makes it ideal for other applications. At Kling Bros. Engineering Works, design engineers have taken advantage of the variable column effect of a cylinder to counter-balance an overhung milling head on a beam and column mill.

The weight of the milling head and 40-hp spindle drive motor on the

BRAD BARTLETT, *Chief Engineer*, ERNEST L. KAISER, *Design Engineer, Kling Bros. Engineering Works, Chicago, Ill.*

COUNTERBALANCING CIRCUIT

Kling Mill all high speed face mill is 2000 lb. and its vertical speed varies from 40 to 80 ipm. Calculating only the horsepower required to raise the weight of the milling head at the maximum speed gives about 4 hp. This is in addition to the power required to supply milling forces. The reversible electric gear motor which was selected to drive the milling head up and down is rated at 3-hp and its output shaft rotates at speeds of 140 to 280 rpm driving the head through a screw.

COUNTERBALANCE SYSTEM

The milling head rides on ways and its weight is suspended by a link chain relieving the screw of large frictional forces. The chain rides over three fixed pulleys and a pulley mounted on the cylinder rod as shown in Figure 1. The end of the chain is fixed to the machine frame.

The counterbalancing cylinder, which is mounted inside the machine frame for space saving, is supplied with fluid by a dual gear pump. This pump has two sections with capacities of 1 and 2 gpm and supplies the clamping cylinders of the machine as well as the counterbalancing system. The 2-gpm section of the pump is normally unloaded through a 3-way solenoid-operated valve. This valve is energized to direct fluid from the 2-gpm section into the system when the milling head and the cylinder piston are traveling up. Both sections of the pump are then required to supply the cylinder.

A relief valve connected to regulate pressure in the counterbalancing cylinder is set at 480 psi. The counterbalancing cylinder has a 3¼-inch bore and a 36-inch stroke. The 480 psi pressure acting on the cylinder piston produces a force of 4000 lbs. Because of the pulley arrangement and the fact that the chain is fixed at one end, this force just balances the 2000-lb milling head. For this same reason the cylinder moves at only 20 to 40 ipm—just half as fast as the milling head.

During the up-stroke of the cylinder at 40 ipm, 1.44 gpm are required to maintain the cylinder full of fluid. Since both sections of the pump are delivering to the system, 1.56 gpm is dumped over the relief valve. During the down-stroke of the cylinder at 40 ipm, the cylinder is exhausting 1.44 gpm and the pump is delivering 1 gpm, so that the total of 2.44 must be dumped over the relief valve.

CLAMP SYSTEM

In addition to supplying the counterbalancing cylinder requirements during the up-stroke, the 2-gpm section of the pump provides fast action for the clamps of the machine. The electrical control circuit is designed so that the unloading valve solenoid is actuated by the pushbuttons controlling the clamping cylinders. When the pushbuttons are held down, the clamp cylinders are supplied by the full pump output of 3 gpm for fast action. When the pushbuttons are actuated only momentarily, the clamps operate on 1 gpm for slow action.

A swinging arm clamp is operated by a cylinder through a rack and pinion. This swinging arm rotates 90 degrees to clear the work and permit its removal upward. Two cylinders of 4-inch bore and 8-inch stroke are mounted on this swinging arm and are controlled by one valve. The cylinders may be operated together or one may be operated alone by closing gate valves at the ports of the other cylinder. ▼▼▼

FIG. 2. CLAMPING CYLINDERS are shown in this view. Small cylinder at extreme left rotates swinging arm through rack and pinion. Side clamp cylinder shown below has a bore of 5 inches.

FIG. 3. POWER UNIT for the machine consists of a dual gear pump of 1-gpm and 2-gpm sections driven by a 2-hp, 1800 rpm motor. Units are mounted on a 9-gallon reservoir bracketed to the machine frame.

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This machine's original design for 4 million pounds was so conservative that its capacity was increased to 10 million pounds by substituting a laminated cylinder and adding a fluid motor driven pump to boost system pressure to 6000 psi.

ADDING 6000-PSI DRIVE

...increases plate stretcher capacity

• By W. R. Matthews

USE of a high pressure pump driven by a fluid motor to step up system pressure from 3000 to 6000 psi is a design feature of the hydraulic circuit on a plate stretching machine. Aluminum plates up to three inches thick, 136 inches wide and 36 feet long are pulled until about two percent permanent stretch has been given to them. Plates are stretched after rolling to relieve stresses and level the surface.

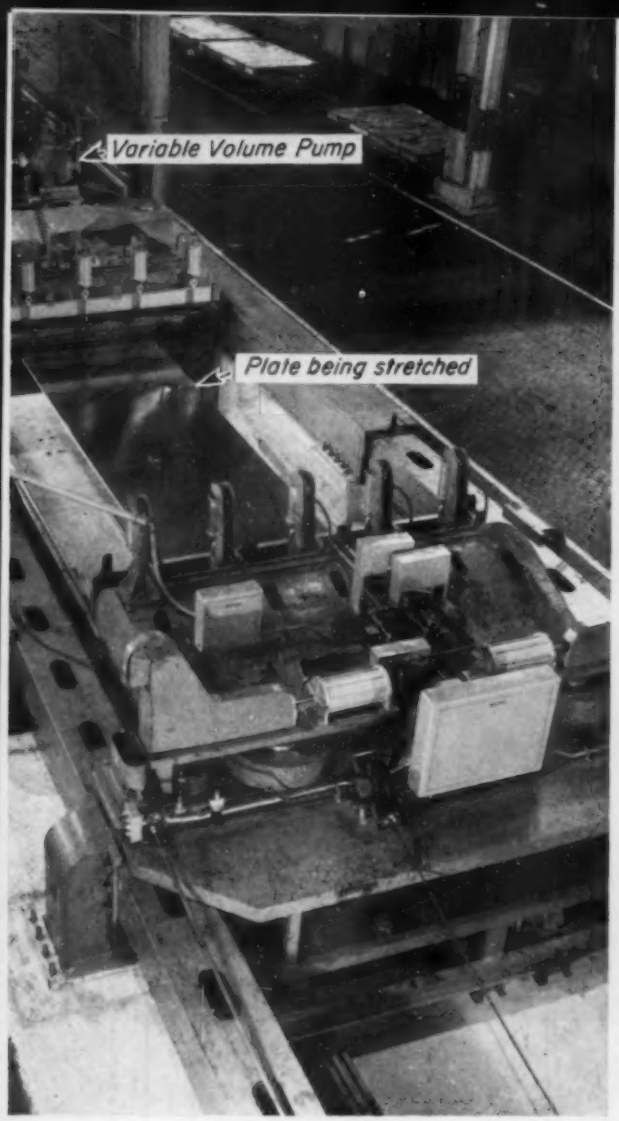
The stretcher-leveler machine is installed at the Trentwood Works of Kaiser Aluminum and Chemical Corp., Spokane, Wash. It can exert a pulling force of 10 million pounds, and the exactness and division of control are ideally handled by the hydraulic and pneumatic systems.

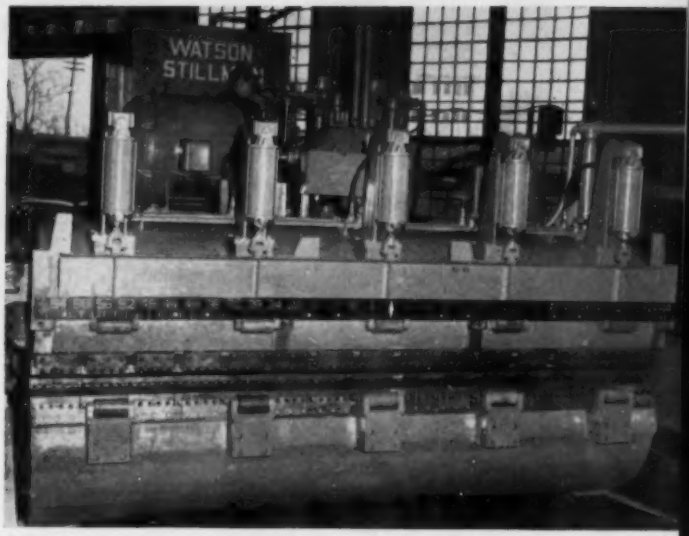
• **Large components**—This stretching requires some of the largest hydraulic components ever constructed for 6000 psi service, and massive structural parts which required months for fabrication. The main cylinder is of multi-layer design. It has 25 laminations, each of plate steel rolled over the inner layer and butt welded to obtain a total thickness of seven inches. The closed end of this cylinder is a steel, dome-shaped casting. The ram is of Meehanite cast iron, 44-in. dia., with an 84-in. stroke.

• **Design change**—Originally designed for 4 million pounds, the capacity of the machine was increased to 10 million pounds pull by substituting the laminated cylinder and adding a pump driven by a fluid motor to increase hydraulic pressure to 6000 psi. The basic design permitted use of the original ram in the new cylinder. The foundations were reinforced to absorb the sudden, tremendous energy released if a plate should break or slip.

• **Controlled Stretch**—The amount of stretch is measured and indicated on a large dial actuated from the movable jaw attached to a cross frame, and pulled by the hydraulic cylinder through a

W. R. MATTHEWS, *Design Engineer, Spokane, Washington*





STRETCHER-LEVELER is 92 ft. long on structural steel foundation set in concrete. Forged steel columns are 65 ft. long and weigh 45 tons each. Movable jaw weighs 48 tons, stationary jaw 35 tons. Ram is 44-in. dia. with 84-in. stroke, operating in 7-in. thick laminated cylinder.

OIL PRESSURE for plate stretching is increased from 3000 to 6000 psi by the fluid motor driven pump pointed to in this photo.

AIR CYLINDERS raise the clamping frame for insertion of plate, then apply proper holding pressure during stretching.

series of pulleys by a cable. As the cable unwinds from a drum, it moves the pointer around the dial, through a solenoid clutch. This clutch does not engage until pressure on the plate takes up any slack, and instantly disengages when pressure drops, if a plate breaks or slips, preventing damage to the dial indicator.

Plate ends are clamped by air at 100 psi. A plate is placed in the stretcher by an overhead crane, which maintains a lift on the center to offset the bending action due to its own weight before sufficient stretch has been established. When the stretch and this bending have been equalized, the large dial is set to register stretch from that point until the desired permanent stretch is attained.

The clamping jaws must divide the total pull evenly or rupture might result. Air pressure control to the clamping cylinders, plus design and adjustment of the jaws, must be very exact. If the squeeze is too great, the plate will be thinned in the area of the jaws, tending to concentrate the stress. Too little squeeze may allow the jaws to slip and give uneven pull, or drop the pull altogether.

Automatic controls are provided so that once set, a stretch cycle can be duplicated exactly. However, in actual operation, the operator watches the

stretch gage and lets the automatic controls take care of timing and hydraulic sequence.

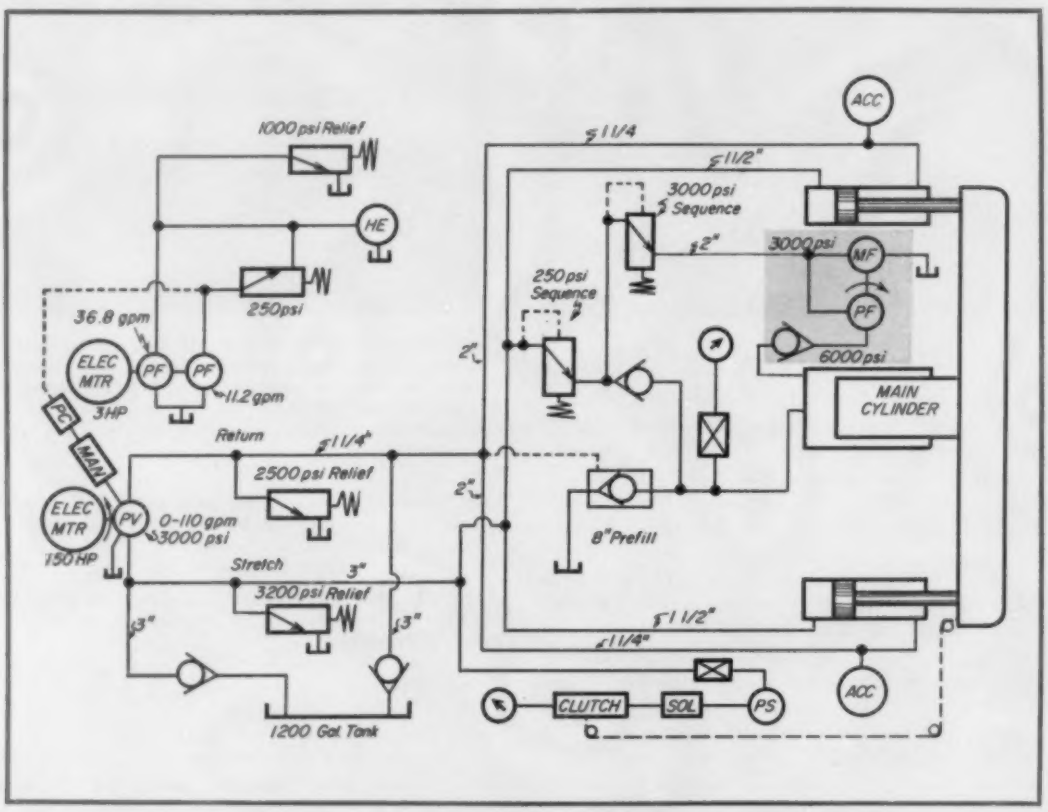
• **Circuit**—This 6000 psi circuit has many novel features, including mounting the hydraulic components and 1200 gallon oil tank so all are protected from hydraulic and mechanical shock. In this design, the columns are in tension, with the rigid tie to the foundation at the head end, next to the movable jaw casting. The tie rods between the main cylinder ram and the massive movable jaw casting are also in tension. Any sudden increase, due to a plate breaking, will not buckle these rods, as would be possible if the rods were in compression or subject to a sudden reversal of stress.

The air cylinders and control mechanism raises the heavy pins tieing the cross yoke to the main column, when it is necessary to change the distance between jaws for longer or shorter plates.

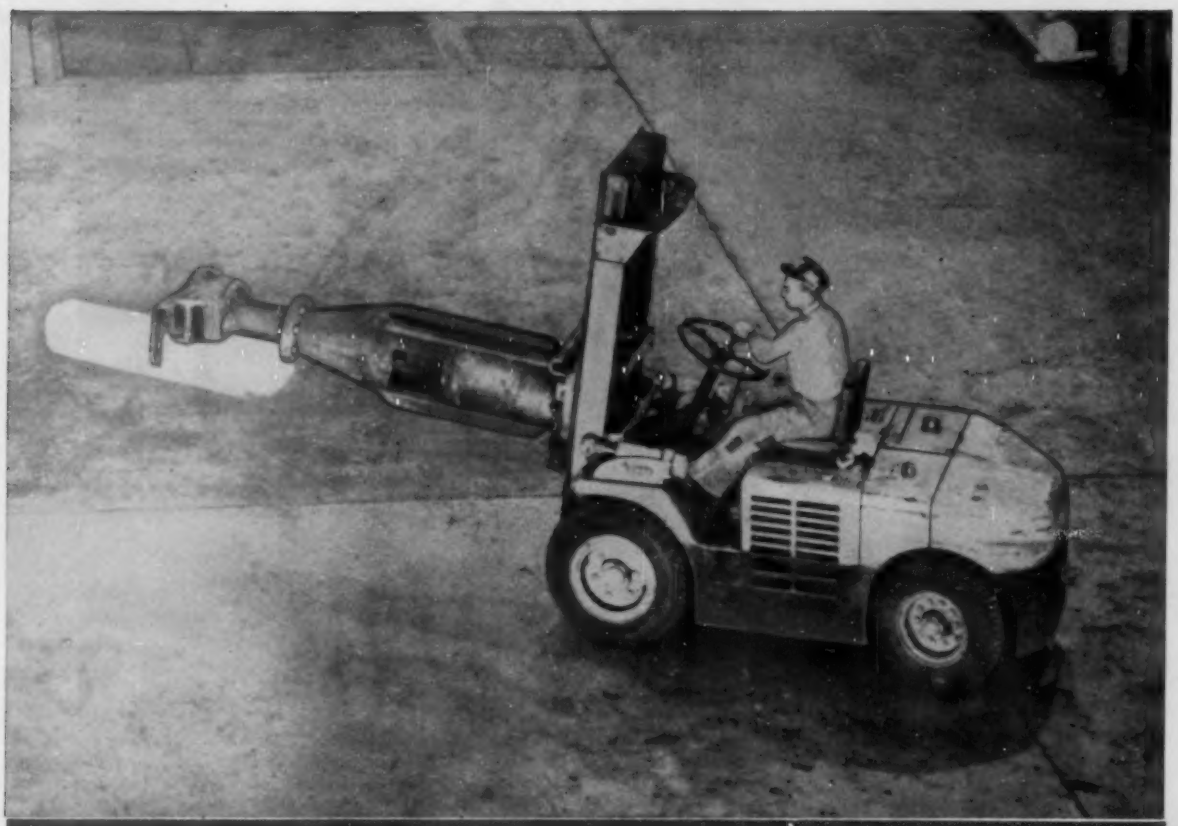
The control handle is mechanically connected direct to the stroke control on the variable delivery pump supplying the main cylinder. This pump is reversible for the return, accomplished by the double-acting cylinders on each side of the main cylinder. The initial stretch is furnished by these rams, while oil is sucked into the main cylinder through an 8-in. prefill valve.

The main pump is an axial piston, variable delivery, reversing type, with servo control and stop to limit delivery to 110 gpm. Originally this stop and the relief valve were set at 2500 psi, but due to increased demands for larger plates, this pump has to operate at 3000 psi. A fluid motor driven pump then boosts this pressure to 6000 psi. Even with this 100% increase in hydraulic pressure, the stretcher has operated very satisfactorily.

• **Lunge control**—A sudden increase in pressure at each jack cylinder, due to main cylinder lunge at moment of plate breakage is partially absorbed by accumulators. In normal operation, the sequence is very smooth and the pull back after stretching is accomplished with no more apparent stress than could be expected from an ordinary press of much smaller capacity. This is due to the component and circuit design, and the near-perfect balance of control functioning. ▼▼▼



STRETCHING PRESSURE is increased beyond the maximum limit of the main variable displacement pump by the addition of a fixed displacement high pressure pump. This pump, driven by a fluid motor, is connected in series with the main pump when system pressure at 3000 psi opens a sequence valve.



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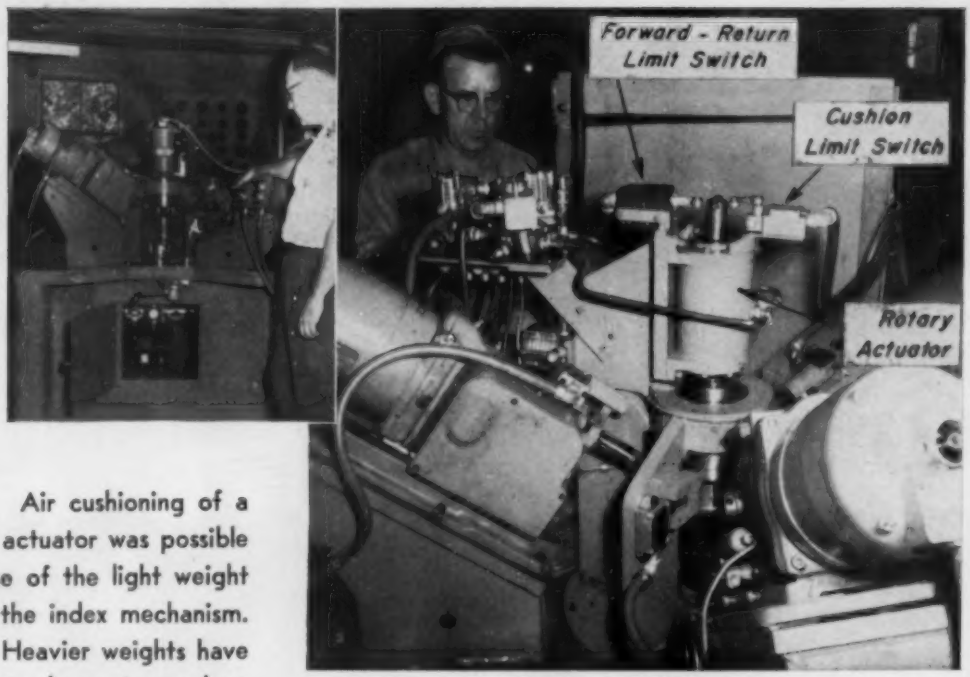

FIG. 1. AN AIR-OPERATED ROTARY ACTUATOR performs the 180-degree indexing required in this special drilling machine. The limit switches which are momentarily actuated by cams on a rod extension of the actuator control direction and cushioning of the actuator. Air line controls and surge tank are mounted in the machine base.

Air cushioning of a rotary actuator was possible because of the light weight of the index mechanism. Heavier weights have a tendency to produce bounce with air cushioning, and hydraulic methods are usually necessary.

AIR CUSHIONS ROTARY ACTUATOR

. . . for 180-degree index

• By R. C. Rowe and J. C. Dale

INDEXING of 180 degrees was required on a special machine built by Center Tool and Die for drilling an automotive transmission part. Because no standard mechanism was available for 180-degree indexing, an air-operated rotary actuator was selected to rotate the work.

The machine was designed to drill 8 small-diameter holes at angles of 70 and 55 degrees with the axis of the work. The problem was further complicated by the requirement that these holes had to be drilled from the edge of the center hole of the work, and the break-through point on the inside had to be the same for all holes.

The first step in planning the machine was the decision that four

R. C. ROWE, *Chief Engineer, Center Tool & Die, Inc., Muncie, Ind.* J. C. DALE, *Sales Engineer, Tec Engineering Corp., Logansport, Ind.*

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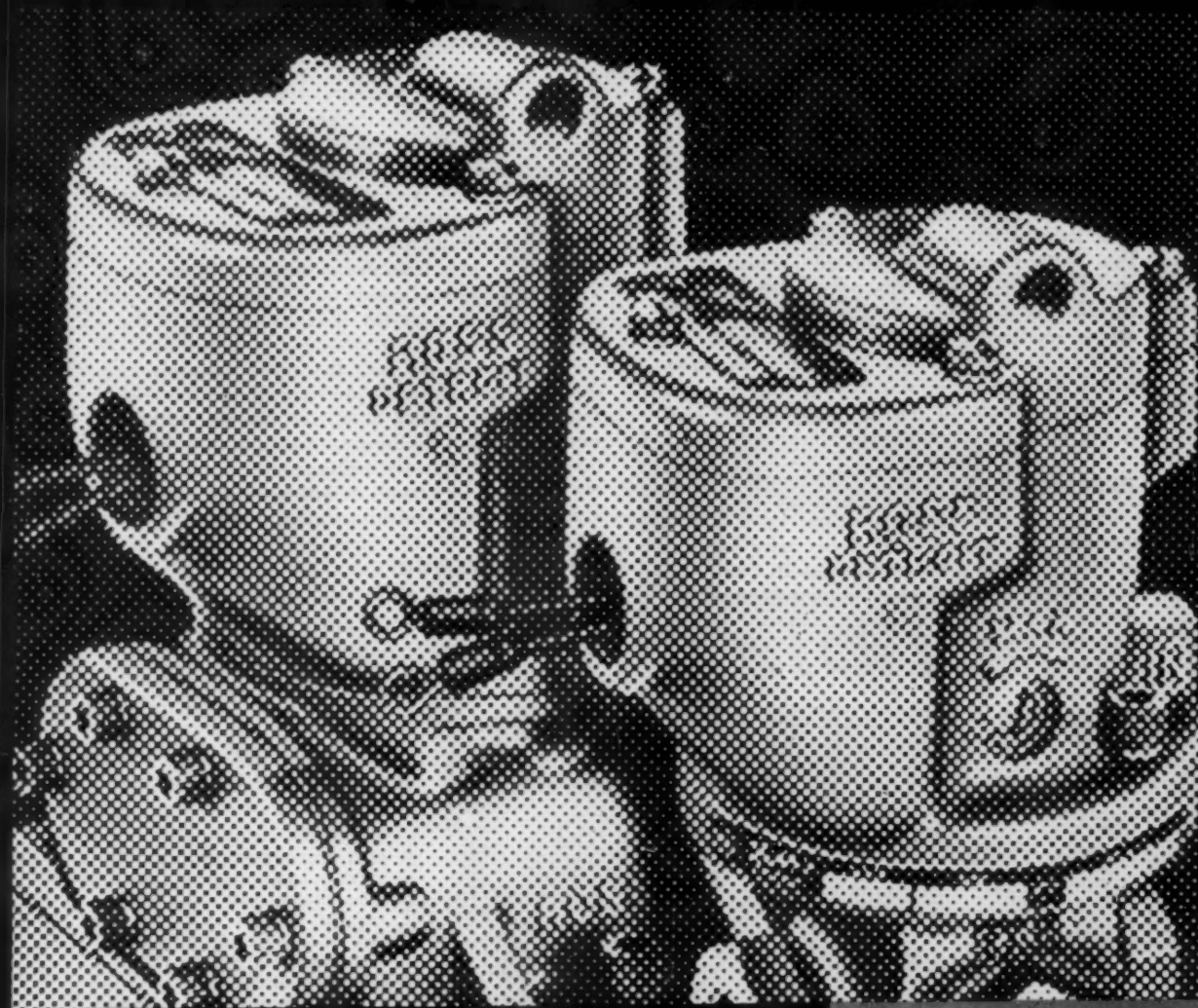

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drill heads should be arranged radially and the work indexed 180 degrees to complete the 8 holes. This arrangement was selected because of the symmetry of the holes. The search then began for an indexing mechanism to give the required 180-degree rotation. Because no suitable index unit could be obtained for this application, an air-operated rotary actuator was applied with necessary electrical controls for starting, stopping, and cushioning to a smooth stop.

PNEUMATIC SYSTEM

The rotary actuator is driven by 60-psi air through a solenoid-operated, 4-way valve as shown in Figure 2. The actuator displaces 16.4 cu. in. of air each cycle, and the air line is a 3/8-inch copper tube for fast action. Indexing time is .6 second; total time for the machine cycle is 34 seconds.

In order to supply the required air during indexing, a surge tank was mounted in the base of the machine. This tank is 26 inches long and 9 inches in diameter, and is mounted lower than the rest of the air components, so that any accumulation of moisture drains into the tank and can be removed. The surge tank eliminates any jerky motion which might occur because of the large amount of air required through the 1/4-inch air line to the machine.

For operation on air, the rotary actuator is chrome plated inside to protect against corrosion. With the air supplied at 60 psi, the actuator develops 250 in.—lb. torque. Although this much torque is not actually required (the index table can be rotated by hand) it was supplied to insure a positive stop at the end of index.

CUSHION DESIGN

The first approach in cushioning the rotary actuator at the end of its stroke was the use of a cam-operated deceleration valve. However, the reciprocating motion of the indexing and the require-

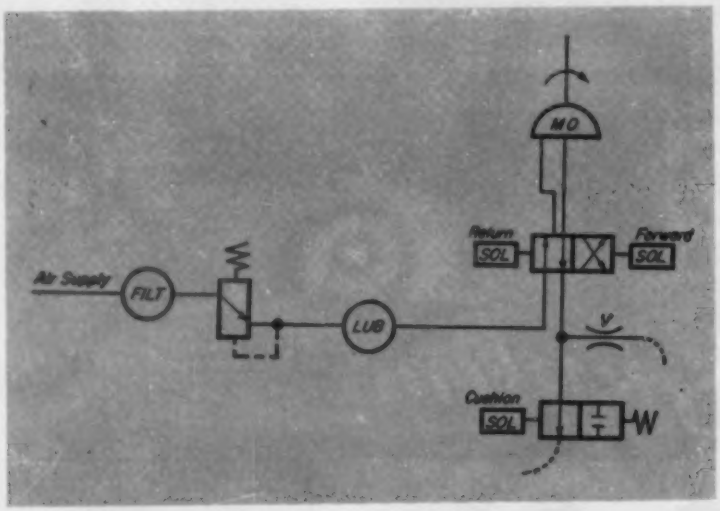

FIG. 2. ACTUATOR DIRECTION is controlled by 4-way solenoid-operated valve with exhaust directed through 2-way spring-loaded, solenoid valve. De-energizing the *Cushion* solenoid forces actuator exhaust through the flow control valve and cushions actuator movement.

FIG. 3. AUTOMOTIVE TRANSMISSION PART must have 8 holes drilled at angles of 70 and 55 degrees with the axis. These holes are started at the edge of the inner hole and must all break through at the same height inside. Symmetry of the hole arrangement indicated 180-degree indexing.

FIG. 4. ELECTRICAL SYSTEM controls the pneumatic indexing. Worked out by the machine designer, the system includes single and double-break relays which channel the signals from limit switches on the drill heads and the rotary actuator to control the machine sequence.

ment for two, accurately mounted cams complicated this design. Actuating a limit switch which in turn controls a solenoid valve is a much simpler and more reliable method.

The rotary actuator is cushioned by deactuating a 2-way solenoid valve which shuts off the free exhaust from the actuator and forces it through a restricting flow control valve.

Determining the point at which the cushion should be applied required some testing of the machine operation, and it was finally determined that the 2-way solenoid valve should be deactuated when the rotary actuator had completed 90 degrees of its indexing travel. Because of the operating time of the limit switches, relays, and valves, the cushion is probably effective only after the last 20 degrees of the 180-degree travel.

MACHINE SEQUENCE

The sequence of machine operations is:

a. With work in starting, 0-degree position, heads move in to drill four holes and return.

b. *Forward* solenoid is energized through the *Fwd-Ret* limit switch to index the work. As soon as indexing begins, the solenoid is de-energized.

c. At the 90-degree point, the *Cushion* limit switch is momentarily actuated to de-energize the *Cushion* maintained-position solenoid. The *Fwd-Ret* limit switch is actuated to the opposite position, setting up the circuit for the *Return* solenoid to be energized.

d. When the index mechanism reaches the 180-degree point, it comes against a positive stop and the *Cushion* solenoid is energized.

e. The drill heads move in and out to drill the second set of four holes. The *Return* solenoid is actuated and cushioning is effected at the 90-degree point the same way as on the forward index.

An interesting safety feature of the machine is the protection afforded by the 2-way solenoid valve if electrical power is lost. Using a valve which is spring-loaded to the closed position insures immediate cushioning in this emergency and prevents the table from slamming into the end stop. ▼▼▼

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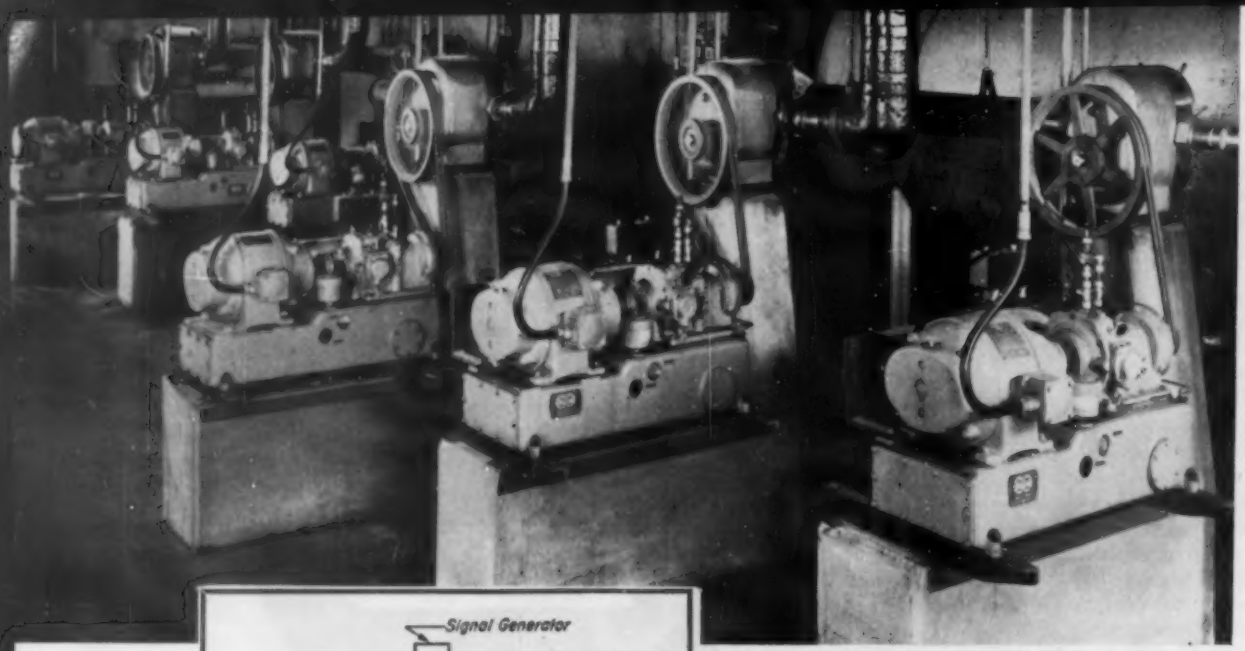

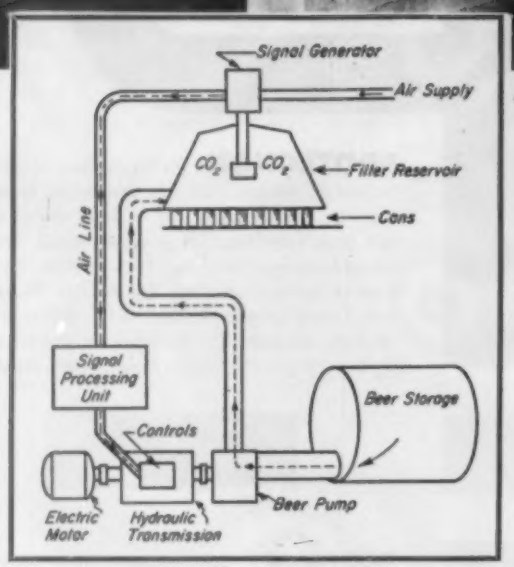

HYDRAULIC ADJUSTABLE-SPEED DRIVES in conjunction with servo controls maintains liquid level in beer-can and bottle filling machines within $\pm\frac{1}{16}$ in. of the desired level.

Beer is pumped from a storage reservoir to the filler reservoir on the floor above. Level is sensed by change in pressure. Higher level corresponds to higher pressure; lower level corresponds to lower pressure. Pressure signal modulates an air transmitter unit whose output is fed to a signal processing unit. Output of the signal processor controls the drive.

Smooth, fast and precise control of liquid level in a beer-bottle and can filling machine is a must. Over or underfilling can be very costly. Here's how a . . .

HYDRAULIC TRANSMISSION

. . . maintains right head on beer

RESERVOIRS in the beer filling machines of a large western brewery are small compared with the flow demands made during the actual filling process. This makes level control very sensitive and requires extremely fast response of the level control system. At the same time the highly carbonated beverage must be handled gently or foaming makes the precise control required impossible. All these requirements are filled by hydraulic transmissions controlled by air-hydraulic servos.

• **Circuit Arrangement**—Beer is pumped from storage tanks to the filler reservoirs on the floor

above by constant-displacement sanitary pumps driven by two-way hydrostatic transmissions. Level of the beer in the reservoirs is sensed by pressure. Low level results in low pressure, and an increase in the level produces an increase in pressure. The pressure signal is transmitted to the air-hydraulic servo control of the transmission to instantly vary drive speed or direction of rotation.

• **Transmission Characteristics**—The hydrostatic transmission is obtained as a complete unit from the manufacturer. Reservoir, variable-displacement pump, constant-displacement motor, all valving and other necessary circuitry are furnished as an assembly complete with electric drive motor. Pump and motor are radial piston type. Reversal of the motor or output shaft is accomplished by reversing the direction of oil flow from the pump. Maximum output speed is 1600 rpm with the recommended input of 1750 rpm to the pump.

Output torque of the unit is 125 lb-in. or starting; 90 lb-in. or continuous operation and 135 lb-in. peak torque for periods not exceeding ten per cent of operating time. Input requirement is from 2 to 4 hp depending upon output required. The transmission unit proper is 17⅝ in. long, 12⅞ in. wide and 8⅝ in. high. Net weight is 95 lb.

The system will increase, decrease, stop or reverse the flow of beer into the filler tank. Overall accuracy is ±1/16 in. Additional features of the system are inherent overload protection and the ability to flush the beer pumps with water under pressure for sanitary purposes without disconnecting the drive. ▼▼▼

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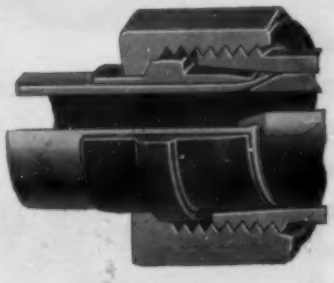

Phantom illustration shows Flodar Self-Flaring hydraulic fitting with nut turned wrench-tight in rockbottom position.

FEATURES OF SELF-FLARING FITTING

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- Guarantees full, unrestricted flow of fluid through tubing.

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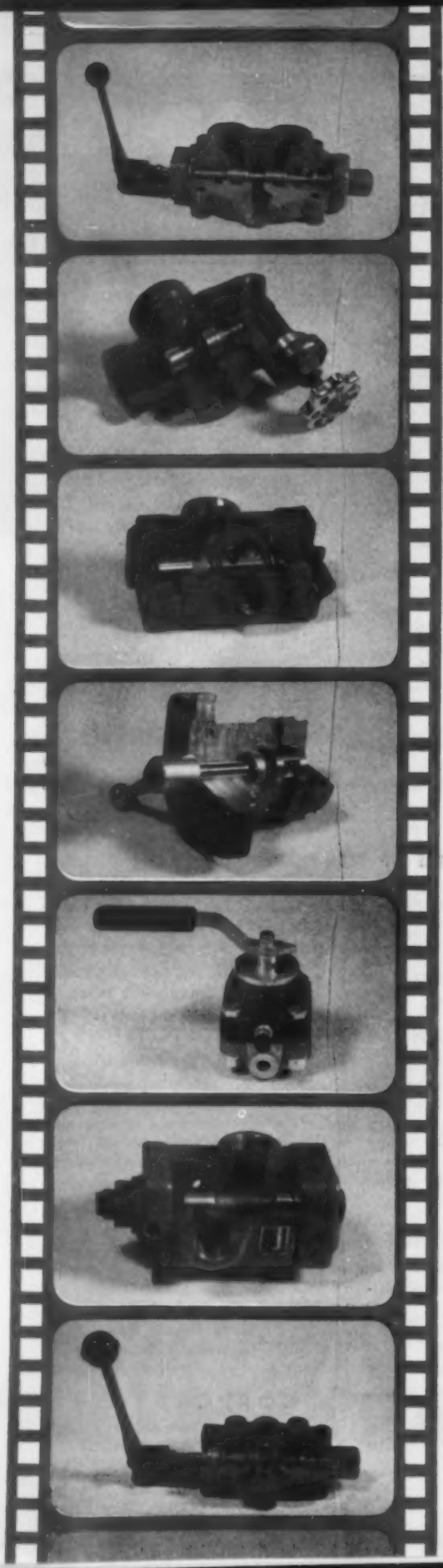


With the rapidly increasing use of hydraulics in industry, it is essential to give maintenance personnel sound training in trouble shooting the new equipment. Here's how one company does it.

HYDRAULICS TRAINING

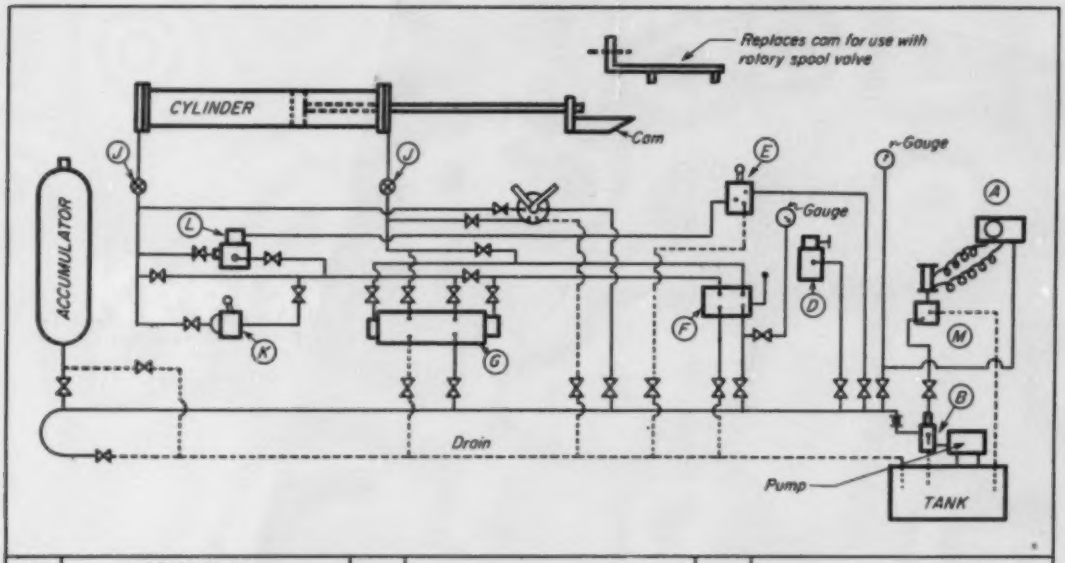
• By R. D. Reeve

INSTEAD of proceeding by trial and error, Republic Steel Corporation sponsors a course in hydraulics as part of their training program. In the first quarter, maintenance men discuss basic hydraulic theories and their application to plant problems. During the second quarter, they make a detailed study of simple valves and circuits. In the last quarter, they analyze hydraulic blueprints and problems involved in trouble-shooting.

• **Realism**—Attendance is voluntary, and after working hours, so the learning situation must be effective and interesting. During each session, the men discuss principles that can be applied to their jobs the very next day. Since a primary objective of the course is to help the employee keep abreast of new developments in hydraulics, the use of new manuals and work on new types of equipment are an integral part of the program.

• **Hydraulic model**—One of the devices used in the training program is a hydraulics equipment board. This consists of a steel plate for mounting various valves. Oil lines are painted red or blue, designating either pressure or return lines. An accumulator, pressure gauges and hoses, interchangeable from one valve to another, are also on the board. Power is supplied by a single horsepower motor mounted on an oil reservoir containing baffle plates and a filter. Also mounted on the reservoir

R. D. REEVE, *Project Leader, Human Engineering Institute, Cleveland, Ohio*



MARK	DESCRIPTION				
A	PRESSURE CONTROL SWITCH	E	CAM ROLLER VALVE	J	VELOCITY CONTROL VALVE
B	RELIEF VALVE	F	MAN OPERATED PILOT VALVE	K	DECELERATION VALVE
C	CHECK VALVE	G	4-WAY DIRECTIONAL VALVE	L	PILOT OPERATED CHECK VALVE
D	PRESSURE REDUCING VALVE	H	ROTARY SPOOL VALVE	M	SOLENOID OPERATED VALVE

HYDRAULICS BOARD permits demonstration of numerous fluid power applications. An accumulator, cylinder, various valves, and hose and tubing are mounted on a steel plate.

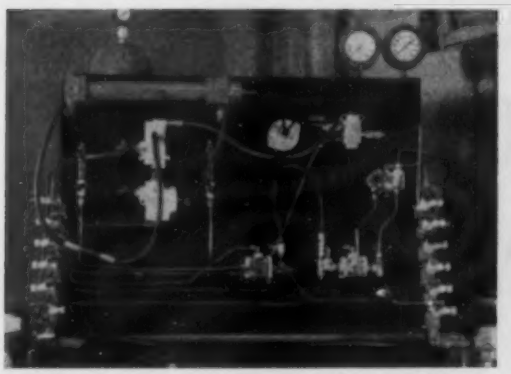
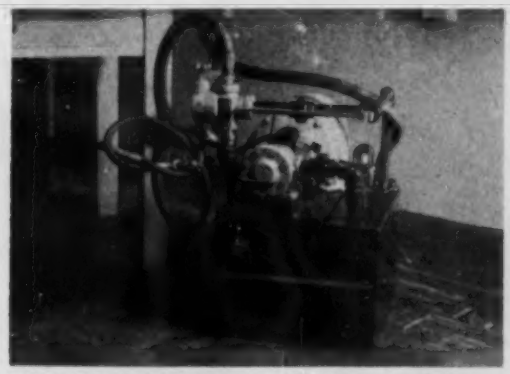


DIAGRAM shows how the components are placed on the board to facilitate setting up various hydraulic applications. System can operate from 100 to 1000 psi.



HYDRAULIC POWER is supplied by a single horsepower motor mounted on the oil reservoir, along with a fluid motor and pressure control valve.

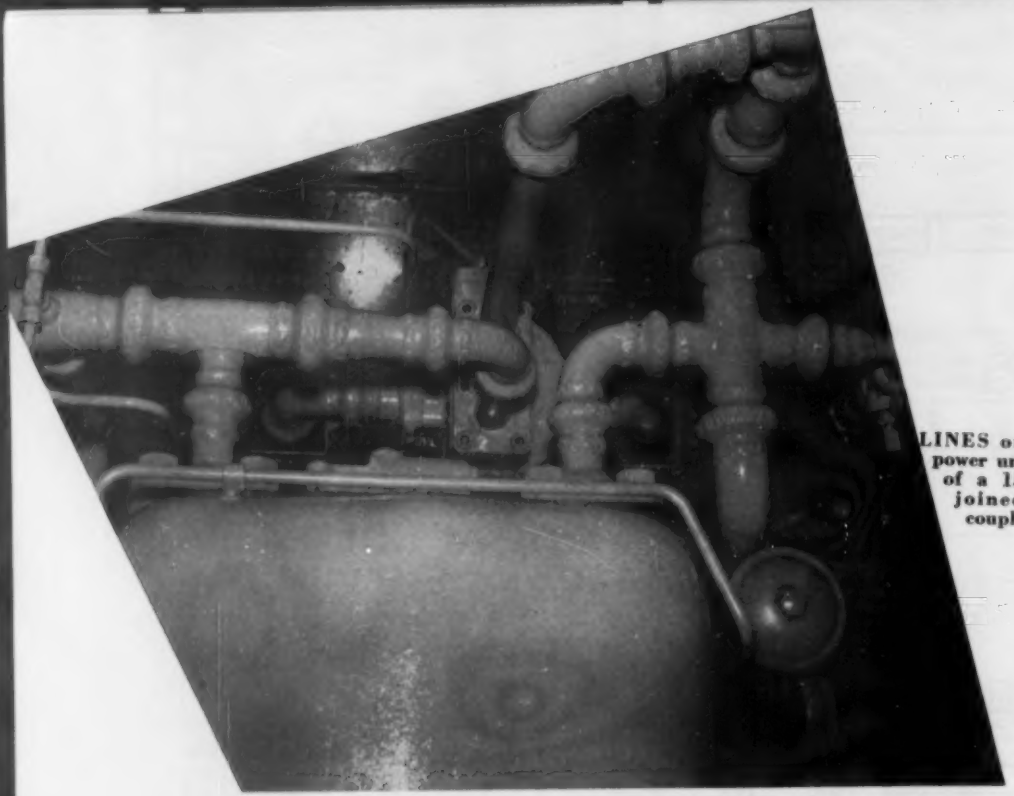
is a hydraulic motor with a pressure control valve to operate the system from 100 to 1000 psi.

• **Demonstrations**—With the training board, audio-visual presentations are possible. For example, while the group discusses an accumulator, they see it in actual operation, understand its characteristics, and learn the safety precautions necessary in maintaining this piece of equipment.

Valves have been cutaway as illustrated, to facilitate understanding. When the men are studying a manually operated pilot valve, they see a valve in actual operation, as well as a cutaway model of an identical valve.

Both manual and pilot-operated systems are studied in detail on the hydraulics board. If the students have discussed the over-all function of manual or pilot control, it is easier to understand the component parts of each system. By applying the knowledge gained, the group members become more adept at repairing breakdowns that occur on their jobs.

• **Trouble-shooting**—Because many breakdowns that occur on the job can be simulated, the hydraulics board is a realistic trouble-shooting aid. Sometimes pressure settings cause hydraulic failures in the shop. This same situation can be duplicated on the board. Thus the maintenance men learn how to make correct pressure settings. ▼▼▼

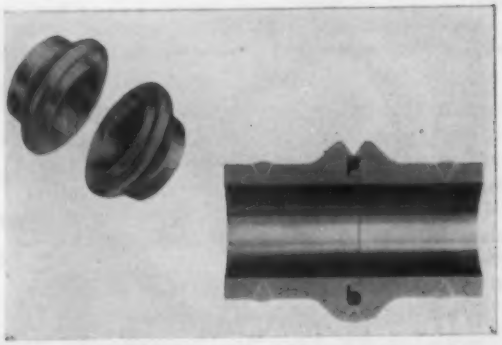


LINES on this hydraulic power unit mounted on top of a 1500 ton press are joined with welding couplings.

Many large press circuits require lines larger than 1-½ inches. One sure method to produce a leak-proof joint is to weld. There are drawbacks: Are permanent joints desired? Will welding greatly increase assembly cost? Will welding scale and distortion cause trouble? Equipment design and use will answer the first two questions. To answer the third . . .

WELDING COUPLING DESIGN

. . . eliminates risk of weld scale damage



CROSS-SECTION through welding couplings shows tongue and groove connection. The cavity prevents formation of welding scale.

• By Gilbert A. Gaum

MANY designers of piping for hydraulic equipment, particularly large presses and other fabricating machinery where fluid lines exceed 1½ inch diameter, prefer welded to threaded and flanged joints. Welding protects against mechanical and thermal shock loads, vibration and other service conditions, and also often cuts piping costs. Optimum flow conditions are attained, pressure losses are minimized and space is saved when

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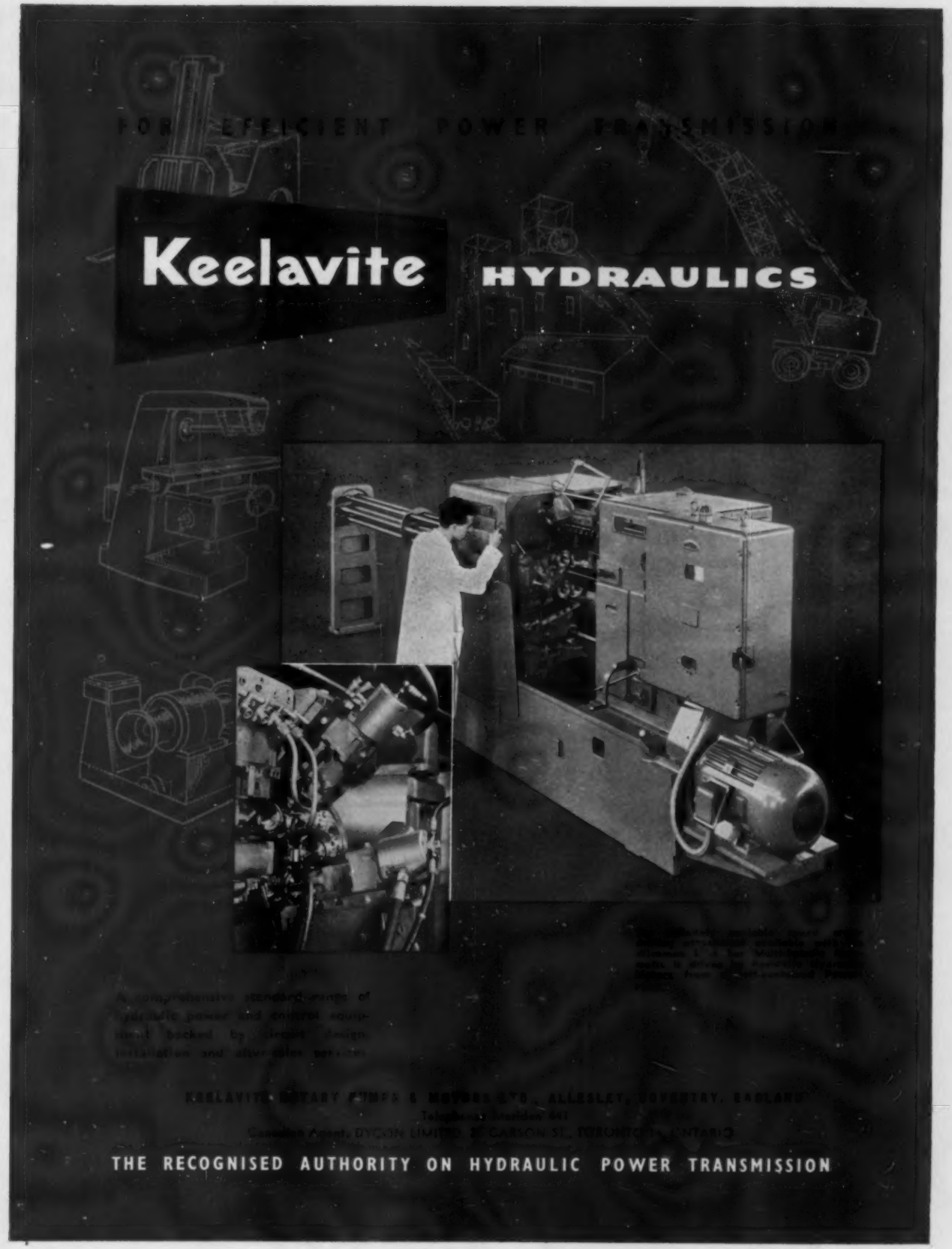
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WELDING COUPLING DESIGN

Continued from page 102

changes in direction are made with forged welding fittings.

While welded piping is more serviceable than threaded and flanged piping, the presence of welding scale is a constant menace to close tolerance pumps and valves.

• **Butt welding**—A great deal of study, time and money have gone into the development of improved hydraulic fluids and packing, in order to increase the efficiency of hydraulic equipment and hold down maintenance overhead. But it is virtually impossible to keep equipment operating properly and to avoid expensive downtime and repairs when piping is joined by conventional butt welding—

JOINT is first tack welded. Final weld produces a high pressure, leak-proof connection.

which frequently entails the use of welding rings. Sooner or later, in all probability, welding scale will contaminate the fluid. Then the packing may be adversely effected, causing leakage and pressure losses, and pumps, valves, instruments and other vulnerable components may be knocked out.

It is reported that many of the pumps and valves returned to manufacturers for repairs have been damaged directly or indirectly by welding scale and icicles.

Eliminating welding scale and icicles from hydraulic piping has been accomplished by the design of the welding coupling shown in the photos.

• **Scale elimination**—This coupling consists of two forged halves with beveled hub ends that match pipe and welding fittings of corresponding nominal pipe sizes. The coupling halves are made to fit snugly together by means of a tongue and groove arrangement that automatically insures perfect alignment.

When the coupling halves are joined, a circumferential cavity is formed just below the welding bevel. This cavity enables the welder to obtain complete penetration in the final weld, without burn-through or formation of icicles. It also insulates the inside surface against the extreme heat of the welder's arc so that no injurious scale can form.

The ends of the coupling are designed for attachment to pipe and fittings by conventional butt welding procedures. After butt welding each coupling to the pipe, welding scale and protrusions are removed with a flexible grinder. Mating ends of the coupling are then brought together and tack welded. The tongue and groove arrangement makes it easy to align them. The final joint is as strong as the pipe itself and permanently leakproof. Since the interior of the joint is smooth and clean, the hydraulic fluid flows freely through the pipe. Turbulence and pressure losses are minimized and the efficiency of the equipment is increased accordingly.

Should it be necessary to disassemble the pipe, the coupling can be cut apart and reused. The design of the coupling prevents foreign particles from entering the pipe during the parting operation. ▼▼▼

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There's a static reaction or steady-state axial force which tends to close precision-made, spool-type control valves widely used in aircraft and missile control systems. This article reviews and discusses the relative merits of four methods for . . .

REDUCING STATIC REACTION

. . . in spool-type valves

• By R. I. Sinclair and D. E. Turnbull

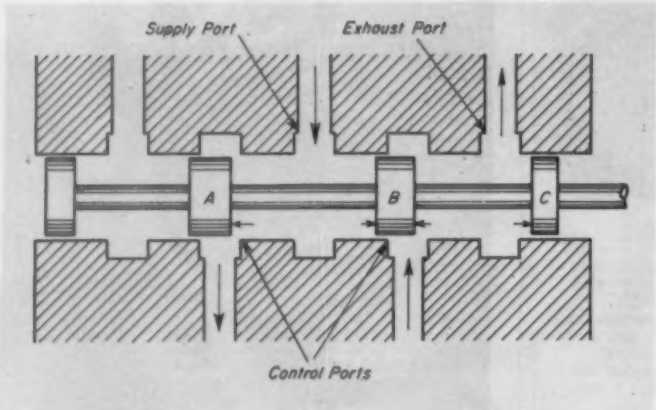

FIG. 1. FLOW AREAS in a standard valve are such as to cause higher static pressures on the left-hand sides of lands *B* and *C* than on the right-hand side of lands *A* and *B*. The resultant force tends to close the valve. Thus, a higher actuating force is necessary.

MANY years ago Bernoulli established the fact that static pressure of a fluid in motion in a pipe increases as velocity decreases. By the same reasoning, the converse is also true. That is, as velocity increases, the static pressure decreases. Keeping this in mind and referring to a standard spool-type valve, Figure 1, it follows that since the control port area is much less than the flow area at any other section of the valve, velocity in the region of the control port is greater and static pressure lower than at any other point in the valve. As a result, static pressure on the right-hand face of land *A* will be less than that on the left-hand face of land *B*. Also, pressure is less on the

R. I. SINCLAIR *and* D. E. TURNBULL, *Engineers, English Electric Co., London, England.*

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right-hand face of land *B* than on the left-hand face of land *C*. Net result is two approximately equal components both of which tend to move the valve spool to the right or close the valve.

• **Balancing forces**—A compensated valve design suggested by Lee and Blackburn[1] is shown in Figure 2. Alterations to the spool and sleeve shown do not change the force on the supply sides of the inner lands. Force on the outer or exhaust portion of the spool is altered by the geometry to give low static pressure on the axial projection of surface *D*

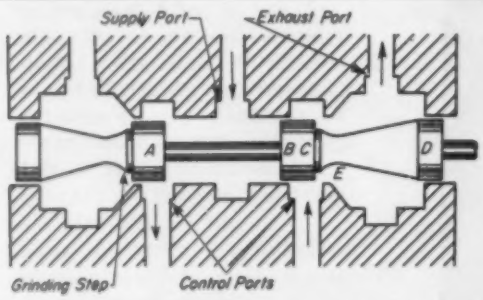


FIG. 2. CONSTRUCTION of this valve balances out or compensates for 95% of the static reaction force. Shape of the exhaust port and spool are such as to direct the flow of oil against the spool so as to exert pressure in a direction opposing the static reaction force.

and high pressure at surface *C* because flow is directed by the geometry of the valve body against this surface. Resultant force on surface *C* tends to open the valve. Proper selection of tapers and other dimensions can produce approximately 95% compensation with this valve design.

However, dimensions in this valve are extremely critical and, of course, geometry of both body and spool are somewhat complicated. Geometry of the small step on the spool is particularly critical.

A second method of compensation which is simpler to manufacture but also less effective is shown in Figure 3. Here the sealing lands are replaced by end seals through which the stem passes. Obviously, this removes one of the faces on which pressure can act to close the valve. This reduces the closing force by approximately 50%. The seals must withstand high pressures and there is relatively high friction because of the seal. Therefore, total compensation is invariably less than 50%. The same general approach may be applied simply by reducing the size of the valve body and spool at the spool ends. However, when this is done, alignment and concentricity become problems.

A third method of axial force compensation has been suggested by Bower and Tuteur[2]. A valve using this design is shown in Figure 4. Although the design was developed for a valve with three lands, it could easily be adapted to a spool having four lands. In this valve two auxiliary lands are

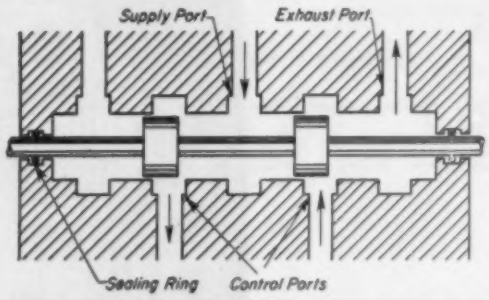


FIG. 3. APPROXIMATELY 50% of the static reaction force is compensated for in this valve by elimination of the end lands against which the higher static pressures act in the standard valve.

incorporated. Oil must flow around one or the other of these and through an orifice created by the addition of dams to the valve body. In flowing through the orifice, the oil loses a certain amount of pressure, and since velocities on both sides of the dam are equal, static pressure on the right-hand face of the auxiliary land is greater than the pressure on face *B* of the exhaust land. Total force tending to close the valve is, therefore, reduced. It is claimed that adding a slight taper to the portion of the spool passing through the dam is a desirable refinement. This will result in somewhat less compensation at large openings and/or flow rates.

Although no figures have been published as to the amount of compensation produced by this method, it is deduced that it would be from 60 to 65%.

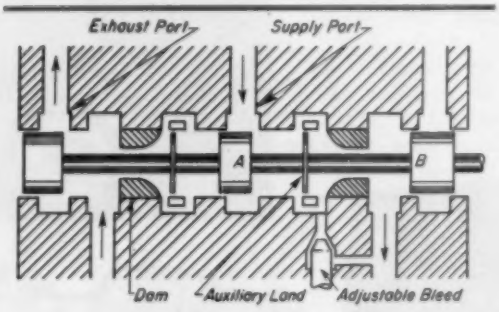


FIG. 4. AUXILIARY lands to redirect oil flow and orifices created by insertion of dams in this valve body compensate for from 60 to 65% of the static reaction force.

Manufacture and assembly of this design appear to be somewhat complex. Characteristics of individual valves can be readily varied by changing size of auxiliary lands and the dams.

Fourth method of compensation is the result of research performed at the University of Cambridge.

Configuration of this valve is shown in Figure 5. The only departure from standard construction is the increase in diameter of the outer portions of the spool. This diameter is such that maximum control port area is just less than twice the annular area between the large-diameter portion of the spool and the valve body. Therefore, oil velocity along the thick portion of the spool is quite high and force on face *A* of the end land is quite low compared with a standard valve. Compensation up to 80% is obtainable by this method. Manufacturing cost of this valve compared to that of the standard valve would probably be less.

Variation in compensation for this valve as diameter of the heavy portion of the stem varies is shown in Figure 6; The curve labelled X_3 corresponds

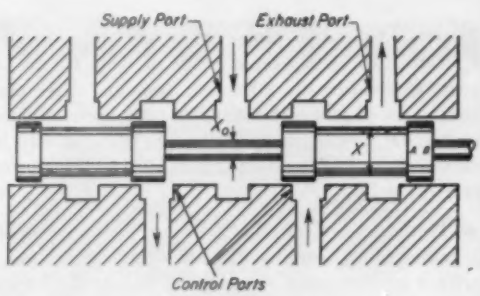


FIG. 5. INCREASED diameter of the portions of this valve spool between the outer lands maintains high oil velocity through the annular area between the heavy portion of the spool and the valve body. This construction will compensate for as much as 80% of the static reaction force.

to a valve whose area relationships are those mentioned in the preceding paragraph. The curve labelled X_4 is for a valve with a thickened portion larger in diameter than that of X_3. Other curves demonstrate how performance is changed as the thickened portion of the spool is decreased in diameter. If spool diameter such as X_4 is used with this type of valve, pressure loss becomes excessive and the flow rate saturates despite an increase in valve opening. This is indicated by termination of the curve for this particular configuration at approximately 75% of full flow rate.

● **Relative Merits**—Degree of compensation of these valves is higher for the Lee and Blackburn valve than for any of the others discussed, Figure 7. Cost is also an extremely important consideration in valve selection, since even a standard valve is a fairly expensive item due to the degree of accuracy and surface finish required. It is, therefore, essential that cost of the method employed should not outweigh the advantages of compensation. Of the four valves discussed, the thick-stemmed valve is the cheapest to produce, and would probably cost somewhat less than a standard valve. The stem-

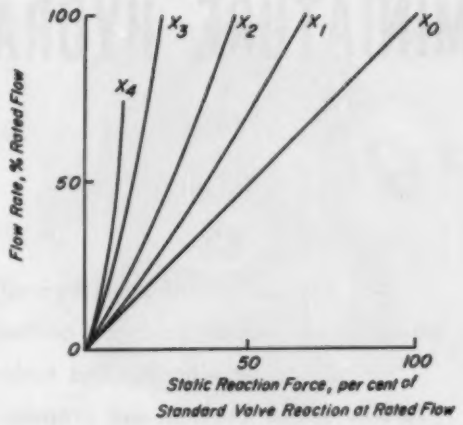


FIG. 6. COMPARISON of static reaction compensation for thick-stemmed valves with various ratios of stem to land diameter. Curve labelled X_3 has a stem diameter such that maximum control port area is just less than twice the annular area between the large-diameter portion of the stem and the valve body. Curve labelled X_4 is for a valve with the thick portion larger than in X_3. Other curves are for spools with smaller stems than that at X_3.

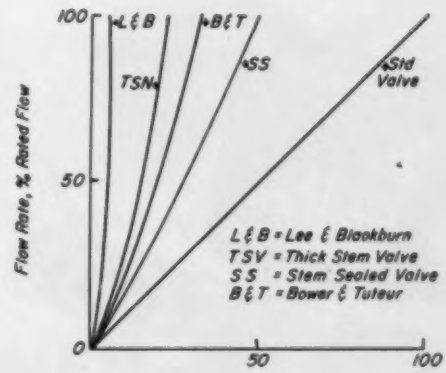


FIG. 7. STATIC reaction forces for the four types of valves discussed compared with static reaction force of a valve with standard construction.

sealed valve is next in order of increasing cost, and would probably not cost too much more than a standard valve. Both the Lee and Blackburn and Bower and Tuteur valves would definitely cost quite a bit more to produce than the other types with the Lee and Blackburn type costing a bit less than the Bower and Tuteur. ▼▼▼

References

1. Blackburn, J. F. and Lee, S. Y.—"Contributions to Hydraulic Control—1, Steady-State Axial Forces on Control Valve Pistons," *ASME Transactions*, Vol. 74, 1952.
2. Bower, J. L. and Tuteur, F. B.—"Dynamic Operation of a Force-Compensated Hydraulic Throttling Valve," *ASME Transactions*, Vol. 75, 1953.

MINIATURE HYDRAULIC POWER SUPPLY

...for airborne applications

Applications of small hydraulic power packs include guidance controls, radar scanning and tuning, turbine speed controls and propulsion system controls. Putting the components for such a power supply into one package leads to great savings of space and weight with an increase in reliability.

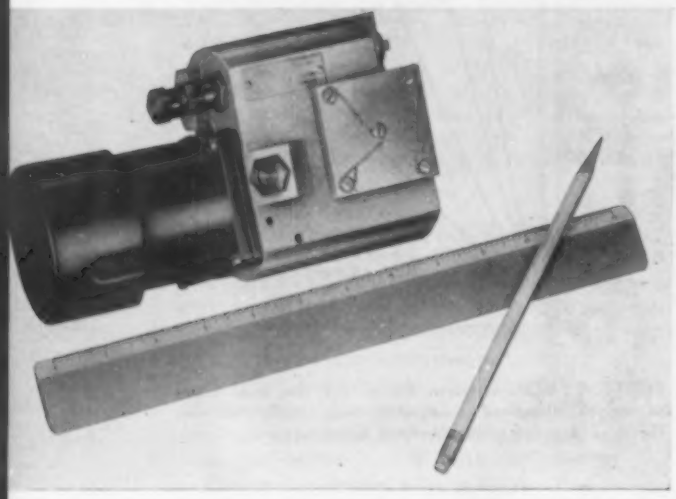


FIG. 1. A completely self-contained source of hydraulic power has many applications in both aircraft and missiles. Small size and light weight are features of the unit. The system is both sealed and pressurized for dependability.

• By Richard Whitcomb and Theodore Mapes

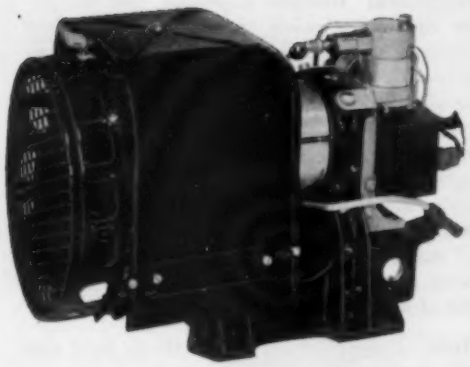
MINIATURE hydraulic power packages are designed to work over a range of from 0.1 to 1.0 gpm. at pressures to 2000 psi. Standard drive consists of an 11,000 or 23,000 rpm, 400-cycle, 3-phase motor. Of course, the pump might alternatively be driven by pad mounting the unit to available power-take-off points.

• **Hydraulic Circuit**—Constant pressure supply is achieved by using a constant displacement pump with a spring-return relief valve, Figure 2. Typical pressure regulation from zero to full-load flow is 10 percent. Since the pump operates against substantially constant load, power input is also constant. When actual load is zero, all power is, of course, dissipated as heat. Use of such a circuit is justified by the small total amount of power actually consumed and by the resulting circuit simplicity and reliability. No speed regulating system is required by the prime mover because of the relatively constant load presented by the unit. Experience has shown that this unit will stabilize at 50 F above ambient temperature when full pump output is being bypassed through the relief valve. A fan on the electric motor shaft helps to cool both the motor and the hydraulic unit. Proper design of the unit such as the provision of cooling fins eliminates the necessity of any additional cooling.

A spring-loaded bypass around the filter is incorporated to prevent excessive drops across the filter when oil viscosity is high because of low ambient temperatures. Bypass valve setting is approximately 75 per cent above known pressure drop across the filter for normal operating conditions. The filter bypass assures almost instant operation of the unit even though oil viscosity is extremely high.

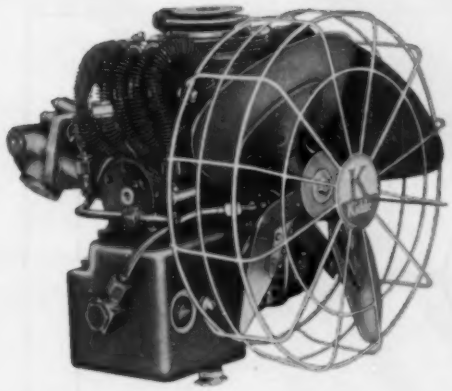
Continuous filtering of pump output guarantees that the system will be kept free of harmful contaminants. Filter used in the pack is porous bronze or other porous medium and is capable of nominal 10 micron filtration.

RICHARD WHITCOMB *and* THEODORE MAPES, *Project Engineers, Eastern Industries Inc., Hamden, Conn.*



2 cfm Compressor Package

4 cfm Compressor



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MINIATURE HYDRAULIC POWER SUPPLY

AVIATION

One of the novel features of the pack is the use of an entirely closed pressurized reservoir. Volumetric changes are compensated for by a small bellows-type expansion chamber which is an integral part of the reservoir and automatically expands or is compressed with a change in oil volume. This feature also compensates for small oil losses due to leakage. Cleanliness, an important factor in any hydraulic system, is improved by the closed, sealed system.

Heart of the system is a miniature, high-speed, gear-type pump, Figure 3. Precision manufacturing techniques enable volumetric efficiencies of 90 per cent to be attained. Overall efficiency from shaft input to hydraulic output is of the order of 55 percent.

• **Mechanical Design**—Extensive use of aluminum castings is made to meet the low-weight requirement for an airborne unit. Successful impregnation of these castings provides the required degree of leak resistance.

Integrated design resulted in all hydraulic connections being made by drilled or cored holes in the castings. This eliminates all external tubing and fittings as well as eliminating many possible sources of leaks. Unit design also makes possible the stocking of entire units for quick field replacement in the event of a system malfunction. Estimated storage life of such standby units is from 3 to 4 years.

• **Fluid**—Either MIL-O-5606 or OS-45 fluid may be used. Because it is compatible with all materials used in construction of the pack, OS-45 is preferred. This fluid is also usable over a temperature range of —65 to 400 F, is not flammable and has a high specific heat. ▼▼▼

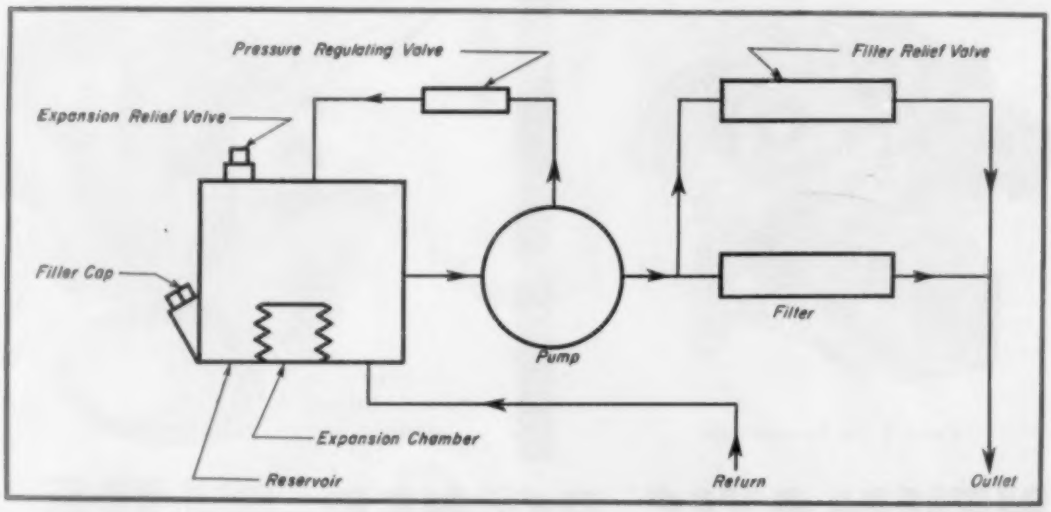

FIG. 2. Circuit of the miniature hydraulic power package is quite simple. In the interest of light weight and economy excess flow is simply bypassed through the relief valve when not required by the external circuit. In such a small unit, total heat generated in this manner is not excessive.

FIG. 3. Heart of the miniature power pack is a small, high-speed, gear-type pump. Pumps of this basic type may be driven at speeds to 24,000 rpm and will provide up to 1.5 gpm at pressures to 1500 psi. The pump shown here is mounted on a ¼-hp, 400-cycle motor.

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Stratospheric altitudes . . . supersonic speeds . . . extreme temperatures subject jet plane parts to almost incredible conditions of heat and abrasion. To assure perfect operation in all circumstances, bearings of hot air valves in the Starfighter are Flame-Plated. A tungsten carbide coating, applied by LINDE's unique method, is the only material tried that successfully eliminated galling and provided a low coefficient of friction over the required service life of the part. With the part Flame-Plated, practically no wear occurred. This LINDE process is now a regular production procedure.

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FIRE-RESISTANT HYDRAULIC FLUIDS

PART 3 – Phosphate Ester Base Types

• By F. H. Langenfeld

PROBABLY the oldest, commercially available, phosphate ester based fluid is Tricresyl Phosphate. This product has been used for years as a fire-resistant hydraulic fluid in certain limited applications. Second in terms of longevity are the Pydrauls and Skydrols manufactured by the Monsanto Chemical Co. In the third group are the Cellulubes manufactured by the Celanese Corporation.

SAFETY

The main purpose of any fire-resistant hydraulic fluid is to protect manufacturing plants and personnel from hydraulic fires. All of these fluids lessen or virtually eliminate the hazards of fire when used as the power transfer medium in any piece of machinery. The phosphate ester based fluids are inherently fire-resistant by their very chemical nature. While they can be made to ignite under certain severe conditions, they are self-extinguishing once the ignition source is removed.

When fire-resistant hydraulic fluids were introduced to industry, special tests were developed for evaluating these fluids in terms of fire-resistance. Three of the most practical tests were molten metal ignition, high-pressure spray ignition, and the hot manifold test. These tests parallel conditions existing in a plant or factory where the hydraulic fluid could be exposed to ignition sources. The tests helped prove phosphate ester based fluids were acceptable for industrial use.

At one time the measure of safety of a lubricant was based on the Cleveland open cup flash and fire test. This test was adapted by personnel within the petroleum industry for identification of certain refinery distillates. Later it was accepted to some extent by this same industry as a means of selecting petroleum products for use based on their ignition hazard rating.

While flash and fire points may be obtained by this test method for the phosphate ester based fluids, they do not reflect true ability to resist ignition. Flash or fire occurs when a phosphate ester has been thermally decomposed. It is the decomposition product that is combustible and not the phosphate ester itself. Certain lubricants on the market have flash and fire points higher than phosphate ester based fluids and yet these fluids may not be considered fire-resistant.

On the list of safety items is the subject of toxicity. If a fluid possesses all of the fine qualities, but is unsafe to handle, it might be ruled out as a commercially acceptable item. The phosphate ester fluids may certainly be considered safe to use, and rank in the same order of toxicity as petroleum oil.

RELIABILITY

Everyone in the field of lubrication regards petroleum oil as an old reliable friend, and finds it difficult to accept fire-resistant hydraulic fluids as

F. H. LANGENFIELD, *Monsanto Chemical Co., St. Louis, Mo.*

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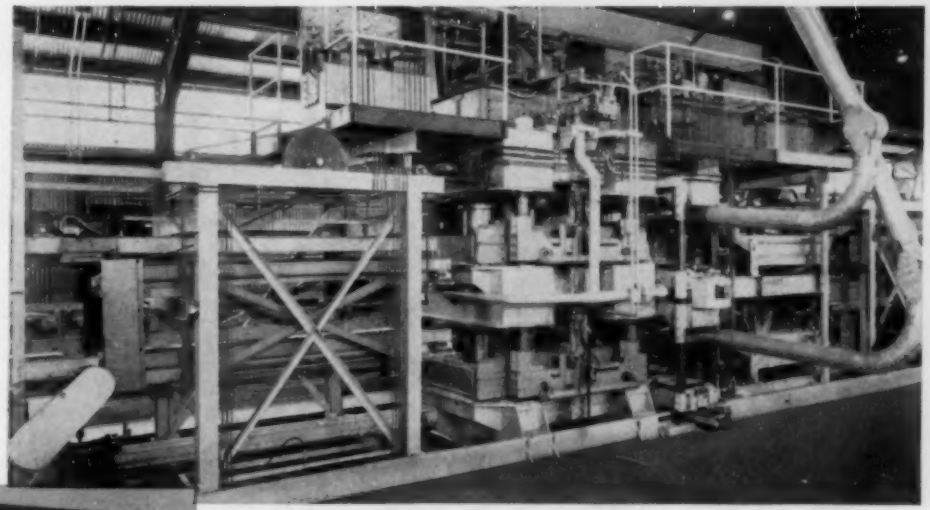

Prepress area of automatic hardboard plant designed and built as a package unit by the Industrial Development Company, Tacoma, Washington for Columbia Hardboard Company, Inc.

Reported to be the most highly automated in the wood products industry, this plant produces 60,000 sq ft of "Cedawood" per day (½" basis).

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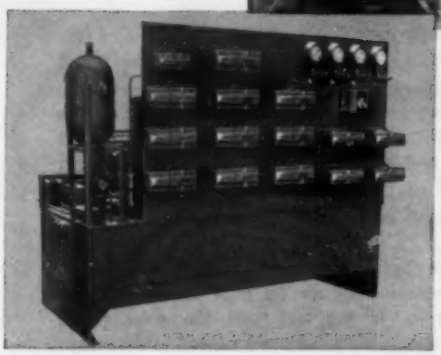

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replacements. Manufacturers in the fire-resistant fluid business know their products must equal or exceed petroleum products in performance if they expect to displace them where fire hazards exist.

Since the petroleum products have been with the industry for years, it is desirable to list the features that make oil reliable and then see how the phosphate ester based fluids compare with these long established standards. The qualities to be discussed are:

Viscosity
Lubricity
Non-Corrosiveness
Stability

VISCOSITY

Phosphate ester based fluids are available in as wide a range of viscosities as petroleum oils. In comparing viscosity characteristics of these fluids with petroleum products, it is found that these fluids will generally undergo a somewhat greater change of viscosity with temperature than will most petroleum oils. This characteristic is generally accepted by industry as being inconsequential. Most equipment used today operates at fairly constant temperatures, thus keeping the fluid at the viscosity desired. In addition, the viscosity pressure characteristics of the phosphate esters are such that viscosities will increase more rapidly with pressures than for comparable grades of petroleum oils. These values are not too significant in the pressure ranges used by industry today, but could be significant in the design of new, very high pressure equipment.

Absolute viscosities of the phosphate esters are somewhat higher than those of petroleum products with comparable kinematic viscosities. Since absolute viscosities are derived by multiplying the kinematic viscosity of the fluid by the specific gravity, and the ester based fluids have appreciably higher specific gravities, there results a higher absolute viscosity.

These are factors of more significant importance to the equipment designers and manufacturers than to the people who are operating equipment with the fluids.

LUBRICITY

Generally speaking, phosphate ester based fluids have lubricities equal or better than premium grade petroleum oils. Lubricity is extremely important in providing long and reliable life to the pumps and other components of a hydraulic system.

There are two major characteristics that a lubricant should possess. It should have sufficient oiliness to protect bearing surfaces from wear, and sufficient film strength to keep these bearing surfaces apart even under varying or impact load conditions, that is, wear and E.P. characteristics.

TABLE 1

SHELL 4-BALL WEAR TEST

	Steel on steel		Steel on bronze	
	1 kg. load	40 kg. load	1 kg. load	40 kg. load
Phosphte Ester Fluids	0.14-0.16	0.52-0.70	0.30-0.46	1.03-1.08
Petroleum Oil	0.20	0.80	0.96	2.71

(Results given in scar diameter in mm.)

TIMKEN B.P. TEST

	OK Load (lbs)	Film Strength (PST)
Phosphate Ester Fluids	35-50	17,000-17,500
Petroleum Oil	Less than 5	Seized

ALMEN WEAR TEST

	Wear (mg. metal lost)
Phosphate Ester Fluids	1.5-2.0
Petroleum Oil	Seized in 1 min.

(Test conditions: 4,000 psi load, 600 rpm shaft speed, 20 min. run).

Three of the most widely accepted tests used to evaluate these characteristics in the laboratory are the Shell Four Ball Wear Test, the Timken Extreme Pressure Test, and the Almen Wear Test. Comparative test results on all three of these tests are shown in Table I. In all three tests, the phosphate ester based fluid was superior to a comparable type petroleum oil.

NON-CORROSIVE

In a hydraulic system there are many metals used in the manufacture of the various components. The fluid used should not be corrosive, nor should it promote corrosion from air or moisture.

Phosphate ester based hydraulic fluids parallel petroleums oils in their inertness to metal and are considered non-corrosive. However, if ester based fluids are operated for extended periods of time beyond their recommended thermal limits, there is the possibility that thermal decomposition will take place and the decomposition products could affect some of the metals in the system. This is equally true of oil under the same operating conditions.

One large plus factor in favor of phosphate fluids, in retention of an oil film for lubrication and protection, is the fact that the ester based fluids are polar compounds and adhere to a surface more readily than do petroleum products.

STABILITY

Thermal Stability and Oxidation Stability are quite closely tied together. It is very difficult to make any all-inclusive statement on the thermal stability of all phosphate ester based fluids, as no two of them possess the same thermal characteristics. Some of them are extremely thermally stable while others show some weakness in this property. In every case, the fluid manufacturer knows the thermal characteristics of his own fluid and prescribes the temperature operating limits accordingly.

These fluids can normally be operated at continuous temperatures between 225 F and 300 F

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For example: The 3-year-old sample above was used in an injection molding machine operated for 40-48 hours per week at temperatures between 100 and 125 F. To see how the used oil compares with its original specifications look at the following table.

Specifications	New Sunvis 916	Sunvis 916 After 3 Yr*
API gravity at 60 F	30.5-32.5	30.3
Flash, open cup, deg F, min	400	400
Fire, deg F, min	460	460
Viscosity, SUS at 100 F	150-160	173.0
Viscosity index	90	90
Neut. number	0.10	0.05
Color, ASTM	1-1.5	3.5

*Typical Test

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without fear of thermal decomposition. The fluids can withstand temperatures in excess of 300 F for short periods of time, but should not be subjected to these temperatures unless equipment design dictates the necessity. All of the fluids are highly resistant to oxidation.

PAINTS

Phosphate ester based fluids tend to soften or dissolve many industrial paints now used, and act as a detergent on gums and other deposits. When these fluids were first introduced, this plasticizing characteristic was of great concern, since many equipment manufacturers painted the inside of their fluid reservoirs and hydraulic components.

. . . More on Fire-Resistant Fluids

This is the third of a series of basic articles on the different hydraulic fluids currently available.

The first article, published in April, discussed Emulsion Fluids. In June, we ran the second article on Aqueous Base Types. Subsequent articles will be:

Pure Phosphate Ester, by W. D. Matthews, Chemical Div., Celanese Corporation of America.

Change-Over Practice, by Charles R. Schmitt, Manager, Lubrication Dept., E. F. Houghton & Co.

Concluding article in the series will be: Safety & Use Factors, by Lawrence Jackson, Plant Superintendent, Withrow Die Casting Co., N. Hollywood, Calif.

It was felt that this removed material could cause pump and valve malfunction.

Fortunately, field experience proved this plasticizing effect on paints was not harmful to hydraulic system performance. For the most part, the phosphate esters plasticized the paints to the point where they were completely fluid and were readily pumpable. However, it is suggested that after a piece of equipment has been converted to a phosphate ester type fluid, a by-pass filter be connected to the system to pick up any paint particles or other residue that may not have been completely dissolved or removed by the regular system filter.

Once the paint and other deposit material has been removed from the interior surfaces of the equipment, it need not be replaced, as the phosphate ester based fluids are non-corrosive and provide the necessary protective coating for the surfaces.

Today, there are paints and primers available that can be used with this type of fluid if the operator feels it is necessary.

PIPE THREAD COMPOUNDS

Just as the phosphate ester based fluids have a tendency to plasticize some industrial paints, they also tend to plasticize some pipe thread compounds. This has never proved to be too much of a prob-

ARROW
AUTOPNEUMATIC CONTROL
The QUALITY ASSEMBLY
to thoroughly condition and control compressed air for pneumatic power tools and appliances.
• Filters • Regulates
• Lubricates
Assemblies and units supplied in sizes ¼"-⅜"-½"-¾"-1" and 2" NPT.
The ARROW FILTER
• Removes up to 98% Free Moisture
• .001" to .002" Particle Removal
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The ARROW REGULATOR
• Self Bleed Assures Accurate Control
• Instantaneous Response
• In Line Flow
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• Mist Lubrication
• Mist Proportional to Air Flow
• Lubricates Only When Equipment is in Operation
The ARROW DRAIN TRAP
• Fully Automatic
• Operates Independent of Pressure
• Double Sump Action to Protect Valve
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QUALITY PRODUCTS SINCE 1914
Catalog and engineering data on request.
ARROW TOOLS, INC.
1902 S. KOSTNER AVE. • CHICAGO 23, ILL.

Versatility of Mechanical Seals Proved by SEALOL . . .

The SEALOL BALANCED PRESSURE SEAL, incorporating the differential area principle, has proved unusually versatile and efficient in rotary shaft sealing applications of all kinds. If your particular sealing requirements are not listed among the actual sealing applications tabulated here, request Bulletin 7 for complete data.

RPM	Shaft Size	Temperature	Fluid	Pressure
36,000	¾"	200° F	Aviation Fuel	300 PSI
1,800	1⅛"	Room Temp.	Ucon Hydraulic Fluid	1500 PSI
11,000	2⅛"	200° F	Lube Oil	20 PSI
6,800	5"	125° F	Lube Oil	Atmos. Pressure
80	2⅛"	350° F	Steam & Hot Air	Atmos. Pressure
7,700	5¼"	350° F	Lube Oil	2 PSI
53,000	1"	350° F	Oil & Steam	350 PSI
70,000	⅜"	230° F	Oil Mist & Air	19" Hg. abs.

Slightly modified versions of the basic Sealol seal make it suitable for almost any rotary shaft sealing application.

RPM	Shaft Size	Temperature	Fluid	Pressure
12,000	2¼"	—300° F	Liquid Oxygen	250 PSI
30,000	1⅛"	125° F	90% Hydrogen Peroxide	60 PSI
14,000	1⅜"	160° F	Fuming Nitric Acid	200 PSI
10,000	¾"	300° F	Propyl Nitrate	150 PSI

Write us today about your particular problem. Request Bulletin 7 or send blueprints and specifications for speedy Sealol seal-utions. Write now!

SEALOL CORP

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SEALOL

THE BALANCED PRESSURE SEAL

lem, but it should be called to the attention of manufacturers and fluid users so they can standardize on pipe dopes which are impervious to these fluids as well as petroleum products.

OTHER QUALITIES

There are certain other desirable qualities a fluid should possess if it is to be considered acceptable for commercial use. These include low volatility, non-compressibility, non-foaming, adaptability to existing equipment, and non-conducting of electricity. The phosphate ester type fluids have proved themselves acceptable in every one of these qualities.

FLUID COSTS

Certain compromises have to be made to take advantage of an over-all gain. In order to enjoy the safety these fluids provide, certain shop practices and some types of existing equipment may have to be slightly modified to accomodate the product.

Phosphate ester based fluids range in cost from approximately $3.30 per gallon to as high as $15 per gallon. The variation is determined by the end use of the fluid based on chemical composition. While these initial costs are appreciably higher than the petroleum products they replace, there are many plus factors, besides safety through fire-resistance, which make the use of these fluids quite attractive.

These fluids have exceptionally long service life if operated within the manufacturer's specification. This is best illustrated in terms of the aviation product, Skydrol. This fluid has an approved service life of 4,000 hours when used in the cabin pressurization transmission of an air transport aircraft such as the Douglas DC-6. Comparable petroleum oils in this same application have an approved service life of only 250 hours. Even though Skydrol costs approximately $12 per gallon in comparison to $2 per gallon for the approved petroleum oils, the allowable service life of the fluid alone makes it more economical to use. In addition to having an excellent service life, the fluid itself is readily reclaimable.

All phosphate ester type fluids can usually be reclaimed by the equipment operator through a simple filtration process and may be used over and over again.

While the initial costs for these man-made fluids are higher in comparison to natural fluids, users are gaining safety plus the economies of having a fluid that provides a longer service life and is reclaimable for repeated use.

SEALS, PACKINGS, HOSES

Elastomeric seal and packing materials used in petroleum oil operated hydraulic systems today are not generally fully compatible with the phosphate

ester based fluids. These seals tend to swell and soften in the fluid and may not offer the operational reliability they were designed to offer. However, seals and packings made of other polymeric materials, including elastomers, are readily available, and will provide the long service life to which industry is accustomed.

It should also be pointed out that it is only necessary to change the dynamic seals or packings when converting a piece of hydraulic machinery from petroleum oil to a phosphate ester based fluid. The static seals need not be changed unless the entire piece of equipment is to be dis-assembled at the time, thus providing a convenient opportunity to replace all seals and packings.

Many operators of hydraulic equipment have converted their units to phosphate ester based fluids without changing a single seal or packing. Today they are enjoying the same operational reliability as other operators who did change packings. However, such a practice should be considered the exception, rather than the rule.

Changing seals or packings may sound like a time consuming project, but experience has proved this to be a relatively simple operation. Since dynamic seals are the only ones to be replaced, the number of replacement parts is at a minimum.

Other elastometric items in the system that may require replacement are accumulator bladders or diaphragms. In the case of the accumulator, the bladders or diaphragms should be changed or eliminated. ▼▼▼

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REGARDLESS OF YOUR NEEDS WE CAN SUPPLY THEM

Check these Advantages

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- √ Cylinders meet J. I. C. standards
- √ Airdraulic cylinders for controlling feed in both directions
- √ New design Piston Packing assures minimum of bypass on hydraulic cylinders
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Delivery to meet your requirements.

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WITH VICTOR GAS-O-DOME REGULATORS

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GD 31	0-3600		
GD 61B	0-2500	Excellent Capacity. Compact— 7 lb.— 4" x 6" x 6". —67° to +160° F. Range.	
GD 62B	0-3600		
GD 80	0-5000	Accurate Valve Control. —67° to +160° F. Range.	
GD 81	0-10000		
GD 10	0-500	Self-Relieving Pilot Regulator Control. High Flow Rates.	
SR 10	0-1000	High Pressure, Low Flow. Compact—4 lb. —2" x 6" x 6".	
SR 100	0-30 & 0-40	Corrosion Resistant.	Ammonia (wet or dry) Boron Trifluoride Chlorine (wet or dry) Hydrogen Sulfide, Hydrogen Chloride, Sulfur Dioxide—and other corrosive gases.

VICTOR'S LONG EXPERIENCE IN PIONEERING HIGH PRESSURE GAS REGULATION *is yours for the asking. For details, and complete data on Gas-O-Dome Regulators, see your VICTOR dealer or write us for catalog 341. Dealer inquiries invited.*

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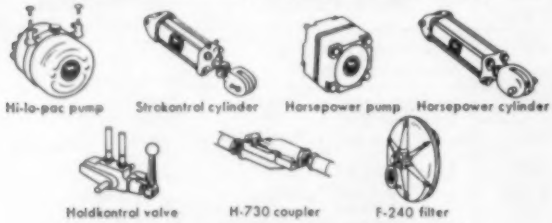
We call it "MARILYN"—it's got everything!

The Char-Lynn HOLDKONTROL VALVE combines ALL features in 1 valve

- ✓ Built-in HOLDKONTROL. This frees the operator from holding the valve in operating position. The valve can be manually returned to neutral, or it will return by itself when pressure exceeds the relief valve setting.
- ✓ Built-in relief valve. Large capacity. Can be set to operate at standard pressure settings . . . 500, 750, 1000, 1500 and 2000 P.S.I.
- ✓ Can be easily converted to control either single or double acting systems.
- ✓ Can be converted to complete manual operation—simple field change.
- ✓ Has 3 point reversible mounting—can be mounted in any position.
- ✓ Will withstand surge pressures up to 5000 P.S.I. It can be safely connected to virtually any hydraulic system.
- ✓ Will sensitively handle volumes from 2 G.P.M. to above 12 G.P.M.
- ✓ Swivel control handle can be rotated through 360 degrees to the most convenient operating position.
- ✓ Special 3-way control without Holdkontrol available for loaders, lift-trucks, etc. Spool change allows operator to inch load up or down.

SPECIFICATIONS

CAPACITY 2 gpm to 12 + gpm • **SAFETY** Relief valve can be set to protect for any range of operation up to 2000 psi • **MATERIAL** Precision-cast body of high tensile strength aluminum bearing alloy. Hardened ground and lapped spool • **PORTS** ¾" N.P.T.—Inlet and outlet.—½" N.P.T.—Cylinder ports • **MOUNTING** Any two of the three pads can be used. Pads reversible for alternate top or bottom mounting • **CONTROL** Spring-loaded . . . Control handle returns to neutral. Handle swivels 360° and may be operated in the most convenient position • **SYSTEMS** Open or closed center. Single or Double Acting. Open free flow or restricted flow • **HOLDKONTROL** Valve will hold when placed in an operating position until it is either manually returned to neutral or until the relief valve operates which releases the lock. This lock can be turned on or off by regulating a screw on operating port face.



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Self-adjusting, easy to install, Seal-Guard's knife-like bronze rings "wipe off" all dirt and grime, will not mar the rod, are oil and heat resistant and friction-free.

HOW SEAL-GUARD WORKS

1. Twin wiper rings are mounted on rod with notches staggered.
2. Cushion ring is compressed on assembly exerting constant inward pressure keeping ring in constant contact with rod.
3. Harmful substances are completely cleared by scraper action.

Seal-Guards are available to fit rod diameters from ¼ to 24 inches. Other sizes by special order.

WRITE FOR DESCRIPTIVE LITERATURE.

HYDRAULIC ACCESSORIES CO.
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AIR-MITE AIR CYLINDERS

Low Cost . . Compact . . Powerful . . Rugged

AIR-MITE Cylinders—made in single or double acting series—in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling or lifting is required, AIR-MITE cylinders will meet your most exacting standards of dependability and long life. Write for complete catalog and prices.

1. Ground and polished steel ram
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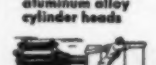
4. Bronze oilless ram bushing
5. Five steel tie rods
6. Brass hose stems

4 Mounting Types



AIR-MITE Devices, Inc.
4401 W. KINZIE • CHICAGO, ILLINOIS

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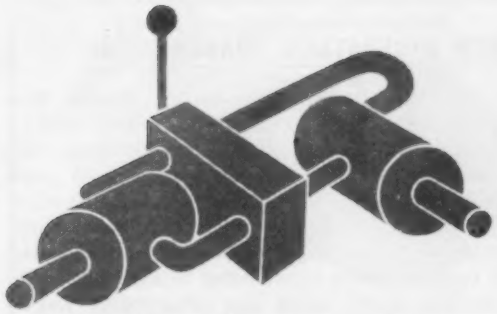
There's a lot of interest in using hydraulic transmissions to propel vehicles. What are the objections to their uses? Size, weight and heat dissipation are a few. European engineers seem to be making headway in overcoming these obstacles.



Hydrostatic Transmissions

MOTORCYCLE AND TRUCK DRIVE

... introduced in Europe

TWO entirely different vehicles, a motorcycle developed in Italy and an industrial truck built in Germany, are being driven by hydrostatic transmissions. Both applications use variable-displacement, piston-type pumps and piston-type motors which are specially designed to become an integral part of the vehicle engine and frame.

ITALIAN SYSTEM

Hydraulic and mechanical couplings are combined in a new infinitely variable transmission developed by Cambri Idraulici Badalini S. p. A. of Rome, Italy. This combination is claimed to produce efficiencies of 96-98% at a torque multiplication ratio of 1:1 and 86% at the maximum available multiplication of 3.5:1.

The transmission consists of a swash-plate pump and motor of similar design with the 7-piston cylinder blocks mounted concentrically, Figure 1. The pump swash-plate is actually an integral part of the motor cylinder block and rotates with it. The motor swash-plate is pivoted in the transmission housing and may be tilted to control transmission ratio but does not rotate. Oil passes from pump to motor through channels in these parts and a distributor valve. The input shaft drives the pump cylinder block and the output shaft is driven by the motor cylinder block.

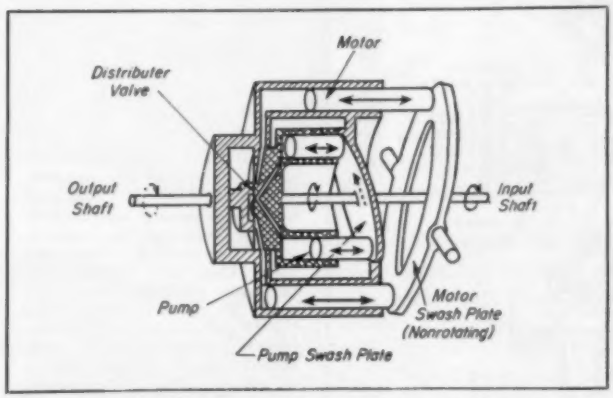


Fig. 1. SIMPLIFIED SKETCH OF THE BADALINI TRANSMISSION shows the relationship of pump and motor parts. Note that the pump swash-plate is an integral part of the motor cylinder block. When motor swash-plate tilt is zero, all parts with the exception of the motor swash plate are locked together by the trapped oil in the unit.

For maximum torque multiplication the motor swash plate is inclined at its maximum angle. Piston stroke is then maximum. Motor speed which is inversely proportional to oil displacement is minimum. As motor swash-plate tilt is decreased, torque multiplication decreases until the 1:1 ratio is reached when the plate is at right angles to its axis of revolution. There is then no reciprocation of the motor pistons and pump and motor units are locked to-

gether by the fluid trapped in the cylinders. This accounts for the 96-98% efficiency at this ratio.

Swash-plate tilt is controlled by a hydraulic cylinder controlled by the vehicle operator. A small gear pump driven by the input shaft supplies oil to the cylinder and keeps the transmission fully charged. To disengage the transmission completely, a bypass valve is incorporated to allow the oil to circulate freely within the transmission. Engine braking and reversing can be obtained by reversing the tilt of the swash plate or by varying the position of the oil distributor valve. Completely automatic variation of torque multiplication ratio with engine speed may be provided by allowing the control cylinder to be displaced by an amount proportional to the pressure developed by the small gear pump since its volume output varies with engine speed.

Units of this type have been built by Badalini in sizes from 150 hp for industrial equipment to a few horsepower for use in motorcycles. In this latter application, production cost, weight and size are reported to be very equal to a conventional 4-speed, geared transmission and a friction clutch.

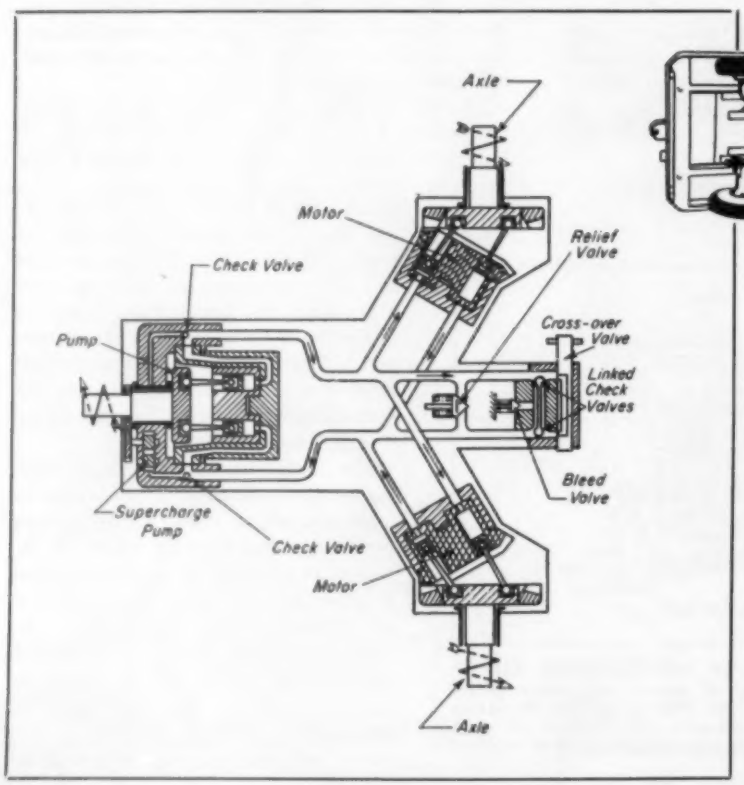
GERMAN SYSTEM

More conventional, in that it has no mechanical lockup, is the system developed by Güldner-Motoren-Werke, Aschaffenburg, Germany for use on a 2-ton industrial truck. An axial-piston pump driven by a 6-hp, single-cylinder diesel engine provides fluid under pressure to drive two axial-piston motors located in the rear axle of the truck, Figure 2.

Speed control as well as reversing are accomplished by varying the degree of tilt of the pump cylinder block. Hydrostatic braking is provided by simply moving the pump cylinder block to zero tilt position. The vehicle operator varies tilt with a lever.

Drive motors have a fixed tilt of 30 degrees and are self-compensating to provide the required differential action since each motor drives one rear wheel. Both motors and the pump are mounted in the Y-shaped tubular chassis of the truck. The chassis also serves as a 9-gallon fluid reservoir. The large surface area of the reservoir provides sufficient cooling for the system. Of course, the use of this structural part of the truck as a reservoir helps to keep total weight of the truck low. Empty weight of the truck is 2000 lb; overall length is 127 in.; width is 49 in.

Maximum speed of the Hydrocar, as it is labelled, is 9 mph in either direction. The aircooled diesel engine has bore and stroke of 2.96 and 3.94 in. respectively. Piston displacement is 27 cu. in. The load carrying platform measures 47 by 87 in. and is mounted to the chassis by four coil springs. ▼▼▼



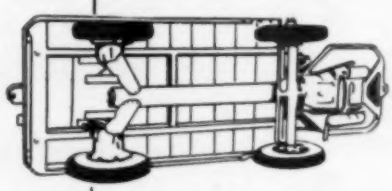


FIG. 2. ALL PARTS OF THE GULDNER TRANSMISSION are contained in the tubular, Y-shaped frame. Cross-over valve is manually operated to permit pushing the vehicle when the engine is not running. This valve is shown in the open position. The bleed valve which is isolated from the high-pressure side of the circuit by linked check balls bleeds off any excess amount of oil supplied by the supercharge pump. Check valves assure that supercharge oil is delivered to the inlet side of the pump. Oil lines are contained within the tubular chassis which also serves as the oil reservoir.

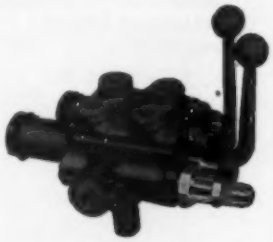
Circle 47 on Reader Service Card

Announcing—

A NEW GRESEN VALVE With FLOAT Position

GRESEN HYDRAULICS

A Two Spool Directional Control With Float



FEATURES: Detent in Float Position—Self Centering From Power Positions—Fully Balanced—Relief Valve Has Replaceable Hardened Seat—Tripod Mounting Feet—Smooth Positive Throttling Action—Hardened and Chrome Plated Spools.

SPECIFICATIONS: Capacity 20 GPM (at 20 Ft/seconds)—Maximum Pressure 1500 PSI—Parallel Application—Shipping Weight 22-1/2 Lbs.

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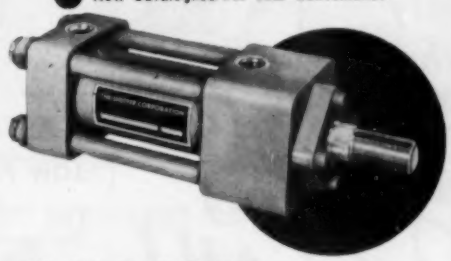

Sheffer's full line of Heavy-Duty* tie-rod type cylinders, series C5H! *3000-5000 psi

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- Square head, compact design requires less space.
- New tie-rod design, for greater shock load capacity.
- "Double-Seal" piston rings minimize gap flow, give maximum life.
- Tapered cushion piston gradually decelerates motion, eliminates common "cushion entrance" shock.
- Multi-lip rod packing is self-adjusting to wear, removable without disassembly of cylinder.
- Ports — straight thread or flanged, with "O" ring seal to eliminate leaks.
- Full range of bore sizes, 2"—12".

SHEFFER

Write for Bulletin 556

THE SHEFFER CORP.

Cincinnati, Ohio

Most complete line of cylinders in the industry

Exclusive territories now open.

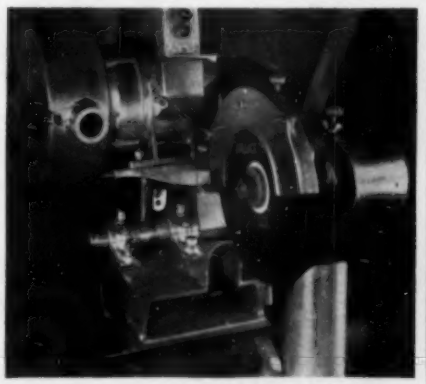
CLEAN, SMOOTH CUTS FOR HYDRAULIC TUBES

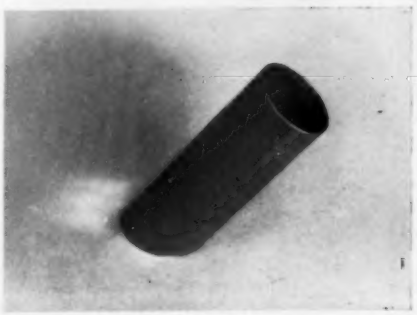
Fittings and flaring require uniform, deburred ends.
This unit cuts and deburrs 1½" tube in just 10 seconds.

It goes to the work—cuts tube, angles, keys, bolts, bar.

Saves labor—no hacksaw, file, rollers, reamer, etc.

Rugged — simple — dependable





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Maker of the famous WALLACE tube benders

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only the **Fall** Gets it All!

WHY be satisfied with only partial removal of dirt or other foreign accumulation from piston rods when you can—

Remove ALL the Dirt from Rod O.D. Stop Dirt Passing Through the Ring Joint with a

Fall "CJ" WIPER RING

The Ring with a Closed Joint!
SPRING LOADED
with Squeeze Grip Action

If you have a wiper ring problem write, wire or phone us.

All Fall Rings are covered by patents issued or patents pending.

ACE PRODUCTS CO.
Toledo 1, Ohio
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You Can Depend on ACE Products—Established 1885!

how the world's largest vacuum furnace safeguards against fire in case of hydraulic line rupture

See page 17, this issue, for an actual history of Vacuum Metals Corp.

(Advertisement)

New Products continued

LOW PRESSURE CYLINDERS

. . . two new lines announced

Designation: AN & BN

Features: Both models have a fork-type rear head for mounting, stainless-steel rods, nylined bearings, high-tensile aluminum heads, honed brass or steel tubing treated for corrosion resistance, and a choice of

fixed or adjustable cushions. Bore sizes are: 7/8, 1-1/8, 1-1/2, 2, 2½, 3, and 4-in. Type BN cylinders use cups for the piston-head seals instead of the O-ring packing used on the type AN. Double packing for the rod gland is also provided on the type BN. All cylinders are available as double-acting or single-acting, spring-return.

Service: 150 psi air, water, 350 psi oil.

A. K. Allen Co.
Brooklyn, N. Y.

Circle 210 on Reader Service Card

DIRECTIONAL CONTROL VALVE

. . . for water hydraulics

Features: Fully automatic, 4,000-lb., 3-way neutral two-pressure control valve is designed for automated control of presses, plastic molding machines and similar equipment. When actuated, the valve applies low pressure for controlled closing. Then, triggered by control timer interval or limit switch, high pressure is applied. When processing is completed, high pressure cuts off, the drain valve opens and the press opens. Valve can be adjusted to provide any throttling speed in any position of the closing or opening strokes. A manually-operated safety control permits instant reversal at any point in the closing phase of the cycle.

Design: Built for use with raw water and other fluids, resistance to corrosion is afforded by cast bronze valve bodies, Monel metal stems with Stellite-faced seats, and replaceable hardened stainless steel seat sleeves.

Sinclair-Collins Valve Co.
Akron, Ohio

Circle 211 on Reader Service Card

SERVO-HYDRAULIC VALVE

. . . is self energized

Designation: SerVan

Features: Design provides repetitive, precise reversal of flow to work element; automatic cycling; and hydraulic lock, with locked-in equal opposing pressures. The valve is entirely self-energized by the hydraulic circuit flow. In case of mechanical or circuit malfunction, the valve "fails safe" by shutting down before reaching reversal point. Positive limit stops can be used since over-travel cannot occur. Accuracy of reversal remains uniform with pressure differentials from 5 to 2000 psi.

Vanguard Engineering
Cranston, R. I.

Circle 212 on Reader Service Card

HEAT EXCHANGER

. . . cools oil circuits

Features: Shell and tubes are made for 75 psi and are tested to 115 psi. All parts and exchanger units are completely interchangeable to permit fast, easy installation and servicing. Bronze bonnets and tube sheets,

seamless copper shells, and brass baffles provide maximum corrosion resistance and long life under adverse conditions. Zinc anodes are also available. Tube bundle can be inspected by removing the bonnets. The tubes can be cleaned easily.

Whitlock Mfg. Co.
West Hartford, Conn.

Circle 213 on Reader Service Card

DEAD-SPACE MEASURING

. . . of hydraulic servo valves

Features: Measurement of dead space in servo valves under actual operating conditions, provides important data on edge conditions. The equipment consists of a holding fixture for oscillating the valve piston, an electronic gaging system

for recording piston motion, and a pressure sensing system to indicate the opening and closing points of the valve of a chart recorder.

Operation: A hydraulic supply pressure of 3000 psi ma and 110 vac 60 cps are required. Measurement ranges are: 0.020-in. range, with resolution of ±0.0002-in; a 0.005-in range, with resolution of ±0.00005-in.; and a 0.001-in. range, with resolution of ±0.00001 in.

Hesse-Eastern
Cambridge, Mass.

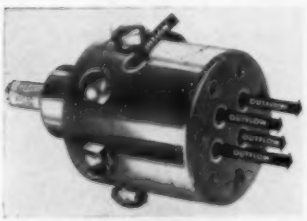
Circle 214 on Reader Service Card

HYDRAULIC PUMP

. . . has isolated outputs

Designation: ISO-FLO

Design: Discharge manifold is made to isolate the power output of one or more of the 7 or 14 radial



pistons from the output of the remaining pistons.

Features: Two or more independent flow rates are obtained by the use of only one pump and motor. Wide variation between the independent flow rates can be accomplished. By adapting separate relief or pressure control valves to the several independent flow rates, one pump can

Continued on next page

For pressures to 5,000 psi
STRATOFLEX
HOSE and FITTINGS
meet your specs
When you design with Stratoflex you get more than the vibration and stress resistance inherent in flexible hose. You get hose fittings designed to meet your specific requirements. Stratoflex hose and fittings are available in a wide range of types and sizes . . . lightweight for aircraft use . . . corrosion resistant for marine applications . . . Teflon* for extremely high or low temperatures . . . heavy duty, double-wire braid types for high pressure. Stratoflex leak-proof, reusable fittings make possible quick, easy replacement or modification. You simplify both design and maintenance when you specify Stratoflex.
*TEFLON is a registered DuPont trademark.
TYPICAL ASSEMBLIES
SF 212 DOUBLE WIRE BRAID HOSE with SF 320 REUSABLE SWIVEL FITTING for high pressure applications. Working pressure range: 1,125 to 5,000 psi.
SF 211 SINGLE WIRE BRAID HOSE with SF 319 REUSABLE SWIVEL FITTING for medium pressure applications. Working pressure range: 350 to 2,000 psi.
SF 124 TEFLON HOSE with SF 324. SWAGED FITTING for aircraft applications. Stays flexible from −100° to +450° F. Unaffected by all fuels, petroleum, synthetic base lubricants, acids, and solvents.
CALL YOUR INDUSTRIAL SUPPLY STORE OR WRITE FOR COMPLETE CATALOG.
STRATOFLEX Inc.
P.O. Box 10398 • Fort Worth, Texas
Branch Plants: Los Angeles, Fort Wayne, Toronto
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Chicago, Dayton
Houston
Kansas City
Los Angeles
New York
San Francisco
Seattle, Toronto
Tulsa

Circle 105 on Reader Service Card

New Products / continued

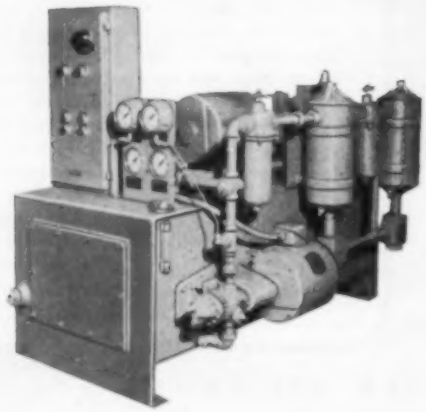
handle a variety of hydraulic operations without a complex valving system. Maximum operating pressure is 10,000 psi.

Applications: Many two pump hydraulic applications, such as rapid movement at low pressure, and slow movement at high pressure can be accomplished with one pump. For example two pistons could be used to deliver 1.5 gpm at 5000 psi, and 12 pistons to deliver 10 gpm at 500 psi. A bypass valve might be used to unload the 12 pistons, leaving the two pistons to develop the high pressure. Or, all 14 pistons could be used to raise the pressure to 5000 psi, where 12 of the pistons would unload—leaving two pistons to maintain this pressure. With accumulator systems, all 7 (or 14) pistons of the pump deliver power to charge the accumulator. At this point, one piston continues to maintain the maximum accumulator pressure after unloading the other pistons.

Simplex Engineering Co.
Zanesville, Ohio

Circle 215 on Reader Service Card

CARDWELL FORCED LUBRICATION UNIT



Provides high pressure wedge to float trunnion with continuous low pressure for lubrication and cooling.

Cardwell custom designs and engineers lubrication equipment to meet your specific job requirements, regardless of application, size and capacity. Write for descriptive catalog and further information.

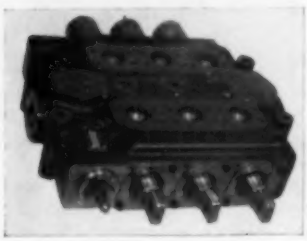
The CARDWELL MACHINE COMPANY
Franklin at 19th St., Richmond 11, Virginia • Phone 7-4593

CONTROL VALVE

. . . has 150 gpm capacity

Designation: Hydreco

Features: Hollow-plunger design provides a check valve built into the control plunger to prevent back flow from the cylinders when operating positions are being changed. Built-in relief valve protects the fluid power system from overload. Three plungers control single or double-acting cylinder as required for operation of heavy-duty, earth-moving, and mobile equipment. The capacity is 150 gpm at 2000 psi.



Kalamazoo Division
New York Air Brake Co.
Kalamazoo, Mich.

Circle 216 on Reader Service Card

PRESSURE SNUBBERS

. . . tend to prevent clogging

Features: Made from brass, aluminum or stainless steel for maximum corrosion resistance, these ⅛-in. NPT pressure snubbers are available in three porosities, for oil, water, and gases, including steam. Intermediate porosities are also available. Extremely fine pore openings of the calibrated insert tend

Continued on page 130

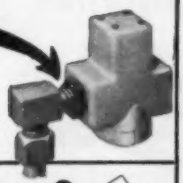
Circle 109 on Reader Service Card

TRU-O-SEAL

TEFLON SEAL

PAT. PENDING

STOPS PIPE THREAD LEAKS



Satisfaction Guaranteed Or Money Back TRIAL OFFER

TRU-O-SEAL Fittings are guaranteed to seal pipe thread connections permanently against all oils, practically all known chemicals and gases; to seal under high pressures or vacuum; to withstand —280° to plus 500° F.; to eliminate "overtightening" damage and pipe dope. Available in ⅛" to 2½" pipe thread sizes.

$10.00 Trial Offer No. 1: eight ⅛", ten ¼", eight ⅜", ten ½" pipe thread TRU-O-SEAL Fittings.

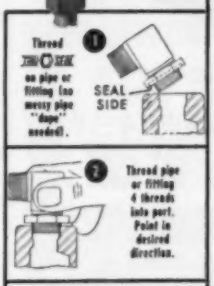
$10.00 Trial Offer No. 2: eight ½", ten ¾", four 1" pipe thread TRU-O-SEAL Fittings.

Send order to

TRU-O-SEAL DIVISION
Flick Reedy Corporation

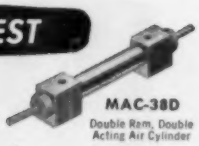
2008 N. Hawthorne • Melrose Park, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.


1
Thread TRU-O-SEAL on pipe or fitting (no messy pipe "dope" needed).
SEAL SIDE
2
Thread pipe or fitting 4 threads into port. Point in desired direction.
3
Tighten TRU-O-SEAL to complete leakproof assembly (only light torque required).

Circle 30 on Reader Service Card

Clippard's NEWEST MINIATURE AIDS TO AUTOMATION!



MAC-38D
Double Ram, Double Acting Air Cylinder

MAC-38S
Single Ram, Double Acting Air Cylinder

MAC-38S
Spring Return, Single Acting Air Cylinder

MAN-12
12-Port Manifold

MAV-2 & 3
2 and 3-Way Air Valves

The pioneer manufacturer of miniature pneumatic devices proudly presents a broad new line of small, but mighty, air components. We are sure you will find them most useful in automatic control and work feeding operations and new end products . . . especially where space or weight is a problem!

Included are new ⅜" bore single and double ram double acting cylinders in 1, 2, 3, 4, 5 and 6-inch strokes; improved spring return cylinders; two and three way air valves and many clever new interchangeable fittings and accessories you have asked for. All are precision made and life tested for millions of cycles of trouble-free operation.

Clippard miniature pneumatic devices have established an enviable "in use" reputation with America's most progressive manufacturers, large and small. You will find them equally dependable, sturdy and easily mounted . . . indispensable for speeding production and improving work quality . . . AUTOMATICALLY!

WRITE NOW FOR NEW CATALOG!

Clippard INSTRUMENT LABORATORY, INC.

7358-H Colerain Road, Cincinnati 24, Ohio

Manufacturers of R.F. Coils, Electronic Equipment, Miniature Pneumatic Devices

NEW Amazing Hydraulic Flow Divider

New Products Flow Dividers bring you an outstanding advantage found in no other Flow Divider.

New Products Flow Dividers can be adjusted, easily and quickly, to change the rate of flow to proper proportions to meet the requirements of the job. The adjustment divides the flow in any desired proportions and will cut the flow from 10% to 95% on the controlled flow side. When set to the required reduction operation is automatic when the excess flow side is pressurized. Thus the Flow Divider gives you full efficiency at all times on both primary and secondary operations.

Two additional advantages give greater flexibility to the New Products Flow Divider. An adjustable orifice varies the controlled flow and a built in relief valve is present to bypass the oil back to the sump when the peak pressure setting of the controlled flow is reached.

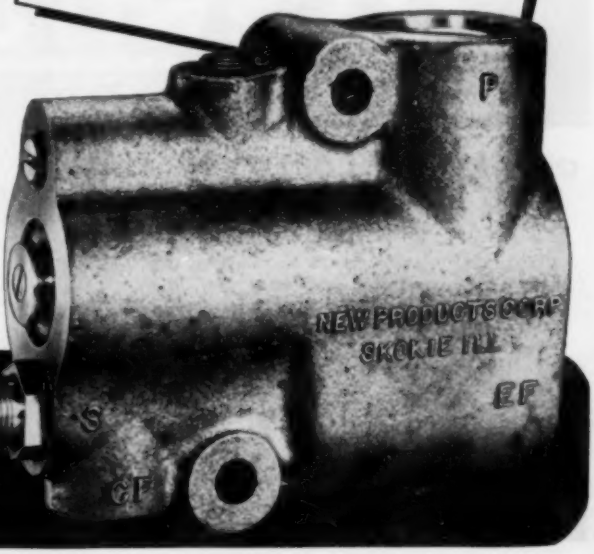
These are features you should consider before specifying a Flow Divider.

Tell us about your problem and let us tell you more about New Products Flow Dividers. There is a size to suit your job.

A SIZE TO SUIT YOUR JOB!	Model 1084.....15 gal. per min. Model 1086.....40 gal. per min. Model 1088.....80 gal. per min.

WHAT IT DOES

- Permits two simultaneous operations from one pump.
- Divides hydraulic flow in any desired proportion.
- Operates on low circulation pressure.
- Adjustable to decrease flow at controlled flow side when excess flow side is worked.
- Has built in relief valve.
- Handles any fluid at any temperature.
- Simple, easy to install and service.



NEW PRODUCTS CORPORATION

3636 Oakton Street • Skokie, Illinois

Circle 75 on Reader Service Card

Circle 7 on Reader Service Card

Hydraulic CYLINDERS to specification

AT your service — since 1918 — the most modern machine tools to handle up to 15" I. D., including the last word in honing equipment and the most accurate of precision gauging equipment. Everything we do is to specification. Expanded facilities permit prompt delivery of 1 or 1000 pieces in any material desired.

Call Erie 2-3664 - Send specifications to

AMERICAN HOLLOW BORING COMPANY

1954 Raspberry St., Erie, Pa.

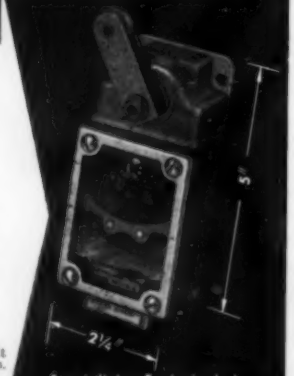
Why leading manufacturers are "SWITCHING" WITH DENISON LOXSWITCH

HEAVY DUTY LIMIT SWITCHES

OVER 5,000,000 CONTACTS AT 75 AMPS INRUSH and still operating!

Typical of the many reports we receive is this actual field experience of one of the "BIG THREE" automotive manufacturers. Results like this prove that LOXSWITCH switches have the reserve capacity necessary for emergency loads. It's the reason why LOXSWITCH outlast all other as much as 5 to 1! Write for catalog 956 giving actual test data and choice of 21 circuits.

LOXSWITCH is a registered trade mark for limit switches—pronounced lock-switch.



Specializing Exclusively in the Manufacture of Limit Switches.

R. B. DENISON MFG. COMPANY

102 ST. CLAIR AVE. N.W. • CLEVELAND 13, OHIO

New Products continued

to prevent plugging or clogging. Snubbers are used to protect pressure instruments, such as gages or switches, against line pulsations or surges. They smooth instrument action, freeing them from distortion and extremes of stress.

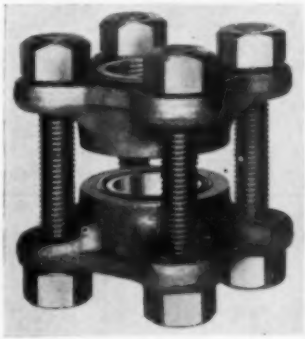
Chemiquip Co.
New York, N. Y.

Circle 217 on Reader Service Card

O-RING FLANGE UNION

. . . for high pressures

Features: Available in 3000 lb and 6000 lb class, 2-bolt or 4-bolt types these unions have screwed or socket-welding ends. Unions are made for piping on hydraulically operated equipment, as well as for refrigera-



tion piping and process liquid and gas lines. O-rings are available in several materials to resist a wide range of industrial fluids.

W-S Fittings Div.
H. K. Porter Co.
New York, N. Y.

Circle 218 on Reader Service Card

HIGH TEMPERATURE LUBRICANT

. . . effective at 1000 F

Designation: #2006.

Features: The high temperature solid film lubricant has been developed for operating temperatures up to 800 F, with several applications to 1000 F. This high-temperature coating is now used on several jet and rocket engine applications, in such places as plain spherical bearings, hinge pins, fasteners and other threaded members; shaft seals and journals; electrical and pneumatic couplers.

Specifications: Coefficients of friction as low as .022 have been meas-

ured under high loads at 550 F. Silicones, high temperature phenolics, synthetic graphite, and micro-fine particles of moly-disulphide are employed in the manufacture of the lubricant.

Electrofilm, Inc.
North Hollywood, Calif.

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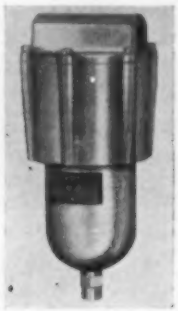
AIR LINE FILTERS

. . . have automatic drain

Features: Filters have simplified design of drain mechanism, more efficient liquid removal, and a wide pressure and temperature operating



range. The drain mechanism has fewer parts and an increased efficiency in filtering operation. Operating pressures are as low as 5 psi and as high as 150 psi for the transparent bowl models and 250 psi for the metal bowl type. Draining is automatic as long as there is pressure in the system. Float-controlled, pilot-operated drain mechanism discharges only when collected liquid reaches full capacity. For removing abrasive solids from the air, three interchangeable filter elements are available—74, 64, and 25 micron.

C. A. Norgren Co.
Englewood, Colo.

Circle 220 on Reader Service Sard

THROW-AWAY AIR CYLINDERS

. . . small bore and stroke

Features: These 1-/16-in. bore,

single and double acting cylinders are available in 1, 2, and 3-in. strokes. Stainless steel bodies insure long life. All models contain vinyl U cups.

Bimba Hardware & Mfg. Co.
Monee, Ill.

Circle 221 on Reader Service Card

HIGH PRESSURE CYLINDER

. . . is all Teflon sealed

Designation: SHEF seal

Features: Unique tube end seal of

Teflon plastic, and rod bushing seal of the same material replace O-ring seals formerly used. Cushion adjusting screw, which is flush with head or cap, has a self-regulating Teflon lock seal which holds its seal no matter where the adjusting screw is set. Opposite the adjusting screw is the redesigned ball check. If interference makes the adjusting screw difficult to reach, it may be interchanged with the ball check. Pressure ratings are 3000 (shock) and 5000 psi (non-shock).

Miller Fluid Power Div.
Flick-Reedy Corp.
Melrose Park, Ill.

Circle 222 on Reader Service Card

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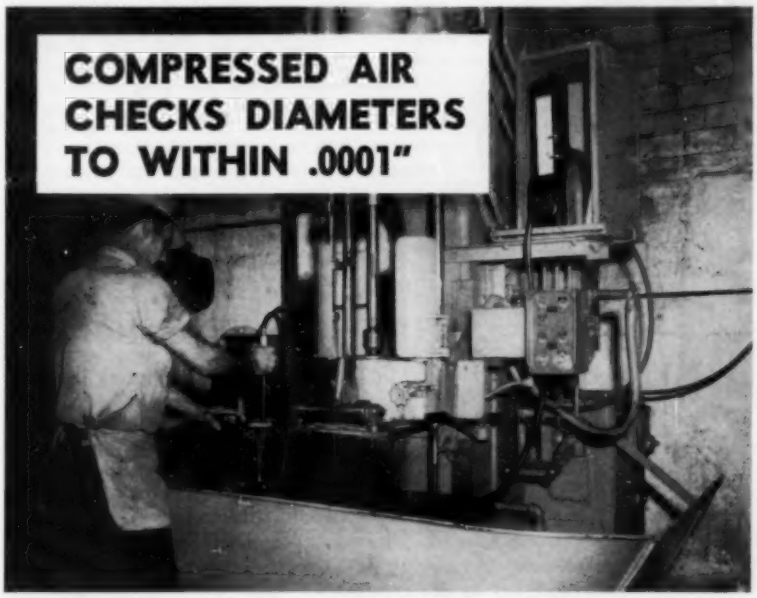
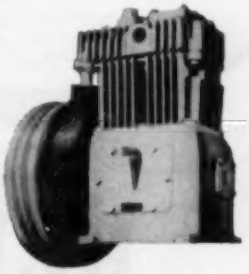


Fast precision gaging with compressed air speeds work flow at this critical honing operation. The vertical hone for finishing cylinder walls is equipped with a Sheffield air gage for checking inside diameters, and the air is supplied by a Quincy Compressor. To measure various diameters, the operator has only to change gage plugs. Scale is highly visible, located out of the work area.

Just another example of how Quincy LOW COST AIR POWER can increase the efficiency of machines and manufacturing operations. Quincy makes compressors for industry from 1 to 90 C.F.M. For help with your compressed air applications, address Dept. AH-87.



Quincy COMPRESSORS

QUINCY COMPRESSOR CO. • QUINCY, ILLINOIS

Circle 85 on Reader Service Card

BELMONT
hydraulic packings

WATERPROOF FLAX

Belmont 300 Series Hydraulic Packing is constructed of the best quality line flax, braided solid, treated with a waterproof lubricant, firmly formed to size and surface graphited.

Ideal for heavy duty hydraulic services such as accumulators, rams, presses, plunger pumps on cold water, oil.

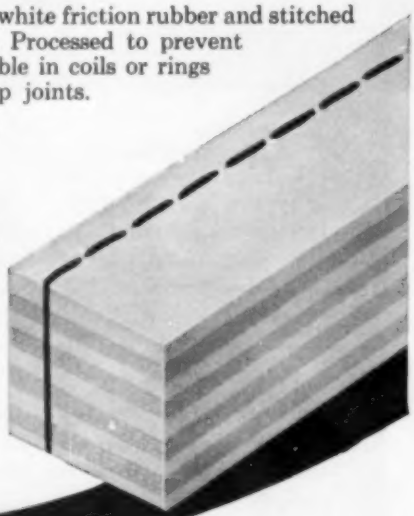
Supplied in 3 grades—hard, soft, very soft. And in coil, spiral or rings with butt joints.

WHITE FRICTION

Belmont Series 10 Hydraulic Packing is constructed to withstand hard service on inside-packed pump pistons and as end rings on plungers and rams in combination with other packings such as Belmont Series 300 shown above. For hot or cold water and oil.

Made of fine sheeting and white friction rubber and stitched with strong linen thread. Processed to prevent excessive swelling. Available in coils or rings with butt, bevelled or step joints.

Write for Catalog No. 56.



ask your BELMONT Distributor

such leading Packing Distributors as:

Manning Packing & Supply Co. in Portland, Oregon
and
Harry P. Leu, Inc. in Orlando and Miami

are ready to serve you promptly and helpfully, wherever you are.

The Belmont Packing & Rubber Co.
Butler & Sepviva Sts., Phila. 37, Pa.

BELMONT

New Products / continued

SOLENOID PILOT AIR VALVE

. . . has 25 million cycle life

Designation: Silver Model, Skyline series.

Features: Tests indicate life expectancy of 25 million cycles. Valve bodies are modular for flexibility.

Straight way, normally-open and normally-closed; three-way open and closed-all in the in line series; and three-way, normally-open and normally-closed; and four-way-all in the base mounted series are available.

Ross Operating Valve Co. Detroit, Mich.

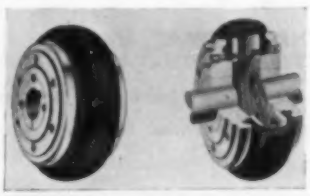
Circle 223 on Reader Service Card

FLEXIBLE COUPLING

. . . uses rubber tire

Designation: Para-flex

Features: Ability to handle angular misalignment, parallel misalignment and endfloat are some of the advantages claimed for the coupling. Flexible member cushions shock



loads and diminishes torsional vibration. The coupling consists of the flexible tire clamped between two hubs which are mounted on the shafts to be coupled. It will take angular mis-alignment to 4 degrees, parallel mis-alignment to 1/8-in., and end-float to 5/16-in. Because there is no metal to metal contact, it requires no lubrication.

Dodge Mfg. Co. Mishawaka, Ind.

Circle 224 on Reader Service Card

FILTER CARTRIDGE

. . . with low pressure drop

Designation: Type PL

Design: Fine quality filter paper, impregnated with a heat stabilizing resin, is pleated and cured at stabilizing temperature. This extended-surface filter is then formed around a metal center tube, and the end plates and a protective shield are attached by a special process.

Features: The cartridge is ideal for full flow filter applications and will filter out particle sizes down to 5 microns. Continuous recirculation results in even finer filtration.

Hilliard Corp.
Elmira, New York

Circle 225 on Reader Service Card

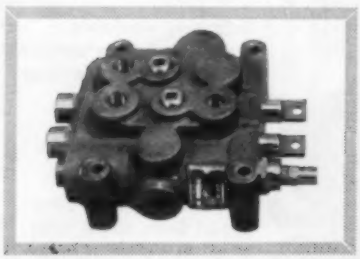
FOUR-WAY REVOLVING JOINT

. . . for pressures to 1000 psi

Features: The joint has four separate passages, each operating on its own center of rotation. It is capable of handling air, hydraulic or steam pressure to 1000 psi. The joints can be made any size required and are capable of either right or left hand

Continued on next page

HUSCO HYDRAULIC CONTROLS *ARE SPACE-SAVERS*



Here's new compactness in a multiple-purpose Hydraulic Control Valve—Husco No. 3600. Its simplified balanced design provides for single or double-acting plungers, individual check valves for each, adjustable relief valve with or without float position and alternate high pressure carry-over. Sizes, 5 to 60 gallons per minute.

Check HUSCO *first* for modern Hydraulic Units, and engineering aid on all your hydraulic developments. Write for details.

HUSCO **HYDRAULIC UNIT SPECIALTIES CO.**
Pumps • Valves • Cylinders
P. O. Box 257-A, Waukesha, Wis.

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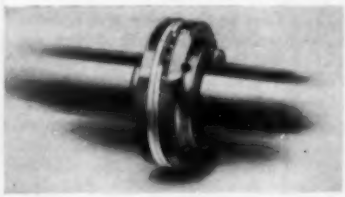
Circle 94 on Reader Service Card

START WITH THE BEST!

Kelon-T (TEFLON)

DUAL PISTON RING SEALS



FOR HYDRAULIC APPLICATIONS — Unique joint design and metal expander ring accommodates dimensional changes due to heat and pressure • Operating temperatures from −100°F to +300°F, and pressures up to 5000 psi • Anti-friction • Chemically inert • Self-lubricating • Pressure responsive • Tough • Corrosion-resistant • Compensate to bore irregularities.

PISTON ROD SCRAPER RINGS

FOR HYDRAULIC AND PNEUMATIC SERVICE — Protect vital O-Rings and Back-ups • Flexible • Long-lived • Self-adjusting • Assure seal reliability and extend packing life in aircraft and industrial equipment • Spring loaded, tough, extremely inert and low in friction, they are responsive to rod misalignments, and do not score the rod • Interchangeable to fit standard groove dimensions.

Contact nearest Representative or either Factory

Use the BEST in Fluorocarbon Products, Specify SHAMBAN!

W. S. SHAMBAN & CO.
11617 W. Jefferson Blvd., Culver City, California
Meyer Road, Fort Wayne, Indiana

KELON

ALMOST 3000 NEW HYDRAULIC EQUIPMENT OPERATORS NOW GET SMOOTH, LONGER PRECISION PRODUCTION RUNS

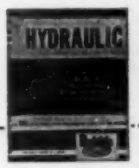
WRITE FOR FREE HYDRAULIC MANUAL SHOWING VARIOUS EFFICIENT SYSTEMS THEY USE TO STOP JERKING SPINDLES AND COSTLY REALIGNMENTS AND ADJUSTMENTS.

Smooth out your hydraulic operations . . cut those expensive stops for sticking valves and jerky spindles, clean up the cause by doing what big nationally known shops are doing. See how they do it without high priced change-over expenses; it's all outlined in this easy to read manual. Write for it today.

Briggs PIONEERS IN MODERN OIL FILTRATION

HYDRAULIC OIL & FLUID FILTERS

PRODUCT OF BRIGGS RESEARCH



THE BRIGGS FILTRATION COMPANY, WASHINGTON 16, D. C.

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SEND ME THE MANUAL ILLUSTRATED AT NO COST OR OBLIGATION

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Company .....

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An important announcement . . .

AIRCRAFT HYDRAULIC DESIGN

• **The first book** dealing with hydraulic component and system design for high-speed piloted aircraft and missiles, has been written by a leading aircraft engineer. Developed from practical and theoretical material, the book develops many basic equations including those relating pressure gradient, flow-path dimensions, flow rate, velocity, fluid density, and viscosity.

• **Design of system components** including actuators, valves, pumps, accumulators, transmission lines and seals is discussed.

• **Hydraulic servo systems** are diagrammed and the transfer functions developed. Fundamentals of transient analysis technique and frequency response method of servo testing are given. The chapter on high temperature hydraulics outlines present progress in fluids, seals, springs, metals, and other critical components, and indicates future developments.

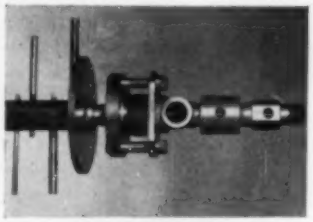
by **GEORGE R. KELLER**
Group Leader,
Flight Control Engineering Dept.
Autonetics, A Division of
North American Aviation

$4.50
10 or more $4.00 per copy
Limited Edition

THE INDUSTRIAL PUBLISHING CORP.
812 HURON ROAD
CLEVELAND 15 OHIO

New Products / continued

rotation, with inner rotating members of stainless steel. The joint is preloaded to eliminate strain on the inner rotating members if the largest rotating member has any run-out.



Rotherm Engineering Co., Inc.
Chicago, Ill.

Circle 226 on Reader Service Card

AIR CONTROL VALVES

. . . have fast operating response

Designation: Speed King series

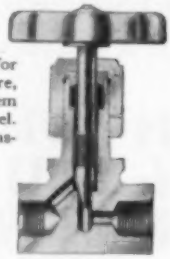
Features: 1/4-in. 4-way, foot-mounted control valves offer compact size, extremely fast operating response and multi-million cycle dependability. Designed for control

REPUBLIC
VALVES
INDUSTRIAL • CHEMICAL • AIRCRAFT

10,000 psi WORKING PRESSURE FORGED BODY

One-piece, stainless steel, forged body and stem guide, with no brazing or welding—*can't* leak or come apart. Has many uses in water, gas, oil, and vacuum service.

Proofed at 25,000 psi for 10,000 psi working pressure, to 200° F. Semi-needle stem of *hardened* stainless steel. Available with graphited asbestos or Teflon packing.



Easy grip handle. Panel mounting. Female pipe connections, sizes ⅛" up to ½".

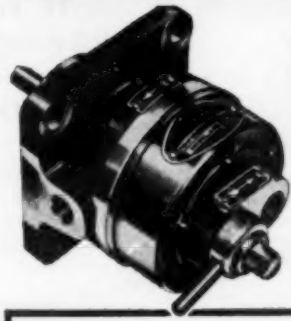
Ask for new catalog No. 654, showing entire line.

Distributors in principal cities coast to coast.

148

RM REPUBLIC MANUFACTURING CO.
15655 BROOKPARK ROAD • CLEVELAND 11, OHIO

SAVERY ANNULAR PISTON PUMP



Infinitely variable from maximum output down to zero. Working pressures up to 1500 p.s.i. Fixed delivery models also available.

This compact rotary pump without Gears, Valves, Vanes or Springs is of unique design and simple in construction.

The pump has the following desirable characteristics:

- Volumetric efficiency as high as 99%
- Absolute positive action and steady uniform flow at slow speeds
- No aeration or turbulence of the fluid
- The path of the fluid through the pump is unidirectional and the internals are constantly swept by the fluid
- No idle pockets or passages to cause air locks or allow coagulation
- Completely self-lubricating, ensuring capacity to run for long periods without attention
- Leakproof

U. S. and CANADIAN AGENT
DAVIES BROS., GLADSTONE, NEW JERSEY

Thomas Savery Pumps Ltd., Birmingham, England

Circle 86 on Reader Service Card

Circle 91 on Reader Service Card

READER SERVICE CARD

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PERMIT No. 8066
SEC. 34.9 P. L. & R.
CLEVELAND, OHIO

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Company _____ Kind of Business _____

Street _____

City _____ Zone _____ State _____

PLEASE SEND ME ADDITIONAL INFORMATION AND LITERATURE ON ITEMS CIRCLED BELOW.

1	18	35	52	69	86	103	120	137	154	171	188	205	222	239	256	273	290	307	324
2	19	36	53	70	87	104	121	138	155	172	189	206	223	240	257	274	291	308	325
3	20	37	54	71	88	105	122	139	156	173	190	207	224	241	258	275	292	309	326
4	21	38	55	72	89	106	123	140	157	174	191	208	225	242	259	276	293	310	327
5	22	39	56	73	90	107	124	141	158	175	192	209	226	243	260	277	294	311	328
6	23	40	57	74	91	108	125	142	159	176	193	210	227	244	261	278	295	312	329
7	24	41	58	75	92	109	126	143	160	177	194	211	228	245	262	279	296	313	330
8	25	42	59	76	93	110	127	144	161	178	195	212	229	246	263	280	297	314	331
9	26	43	60	77	94	111	128	145	162	179	196	213	230	247	264	281	298	315	332
10	27	44	61	78	95	112	129	146	163	180	197	214	231	248	265	282	299	316	333
11	28	45	62	79	96	113	130	147	164	181	198	215	232	249	266	283	300	317	334
12	29	46	63	80	97	114	131	148	165	182	199	216	233	250	267	284	301	318	335
13	30	47	64	81	98	115	132	149	166	183	200	217	234	251	268	285	302	319	336
14	31	48	65	82	99	116	133	150	167	184	201	218	235	252	269	286	303	320	337
15	32	49	66	83	100	117	134	151	168	185	202	219	236	253	270	287	304	321	338
16	33	50	67	84	101	118	135	152	169	186	203	220	237	254	271	288	305	322	339
17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340

READER SERVICE CARD

new | IDEAS • FACTS • CATALOGS
PRODUCT INFORMATION

PLEASE PRINT

AUGUST, 1957 do not use after 11-15-57

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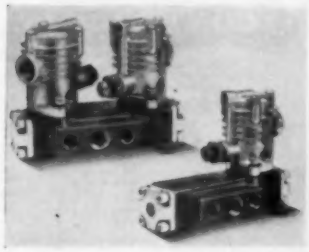
4	21	38	55	72	89	106	123	140	157	174	191	208	225	242	259	276	293	310	327
5	22	39	56	73	90	107	124	141	158	175	192	209	226	243	260	277	294	311	328
6	23	40	57	74	91	108	125	142	159	176	193	210	227	244	261	278	295	312	329
7	24	41	58	75	92	109	126	143	160	177	194	211	228	245	262	279	296	313	330
8	25	42	59	76	93	110	127	144	161	178	195	212	229	246	263	280	297	314	331
9	26	43	60	77	94	111	128	145	162	179	196	213	230	247	264	281	298	315	332
10	27	44	61	78	95	112	129	146	163	180	197	214	231	248	265	282	299	316	333
11	28	45	62	79	96	113	130	147	164	181	198	215	232	249	266	283	300	317	334
12	29	46	63	80	97	114	131	148	165	182	199	216	233	250	267	284	301	318	335
13	30	47	64	81	98	115	132	149	166	183	200	217	234	251	268	285	302	319	336
14	31	48	65	82	99	116	133	150	167	184	201	218	235	252	269	286	303	320	337
15	32	49	66	83	100	117	134	151	168	185	202	219	236	253	270	287	304	321	338
16	33	50	67	84	101	118	135	152	169	186	203	220	237	254	271	288	305	322	339
17	34	51	68	85	102	119	136	153	170	187	204	221	238	255	272	289	306	323	340

of small devices, and available in single and double solenoid types, the valves feature aluminum bodies, end caps, spacers and piston, hard chrome plated stainless steel stem, and O-ring packers. Solenoid pilots are interchangeable between single and double-solenoid types. Coils are encased in molded epoxy resin. Pilot plungers and valve stem are the only moving parts and no springs are used in the main valve body.

Specifications: For 30-250 psi air



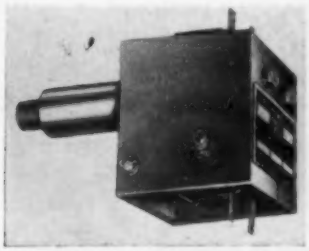
service, valves are offered with solenoid coils for operation on ac, dc, any voltage. Cylinder ports and inlet are tapped ¼ in. NPT; exhaust is tapped ⅜ in. NPT. Port location and mounting locations of single and double-solenoid types are identical.

Valvair Corp.
Akron, Ohio

Circle 227 on Reader Service Card

PRESSURE CONTROL
. . . is light and small

Designation: J51
Features: Designed for applications where space and weight are limited, this control comes in four models



having adjustable ranges of 50, 75, and 250 psi between O and 350 psi limits. On-off differentials between the limits of 5 and 10 psi are available. Pressure settings are uncalibrated, and are made by a knurled adjustment wheel. This adjustment can be provided with a locking feature.
Specifications: Any one of three standard switch types can be provided—normally-open, normally-closed, or double-throw with no neutral position. Switches are rated up to 15 amp at 115 or 230 ac. Also available are 20 amp ac, and manual reset dc.

United Electric Controls Co.
Watertown, Mass.

Circle 228 on Reader Service Card

SILICONE COATED SHEETS
. . . for boots, sleeves, wayguards

Features: Combining mechanical strength of glass fabric with silicone rubber provides a new type of sheet stock that is tough and pliable as well as being heat resistant. Light in weight, the silicone parts take rapid flexing on test instruments and piston rods and still withstand pulling pressure to 600 psi on heavy press rams, steel mill turn downs, and machine tool ways.

Tests: During a 70 hour test at 350 F, in ASTM #1 oil, the volume change was 11%. There was no decomposition or surface cracking. At temperatures from —80 F to 450 F.

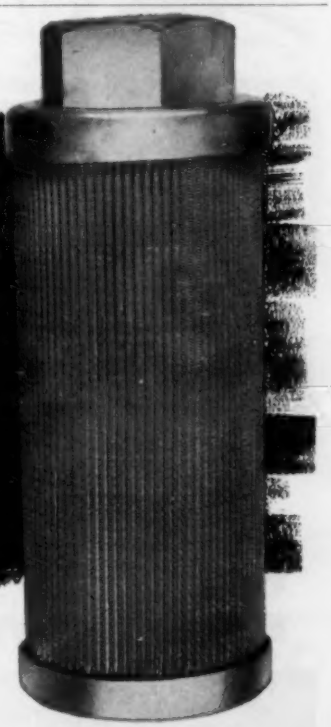
A & A Mfg. Co.
Milwaukee, Wis.

Circle 229 on Reader Service Card

Capital

HYDRAULIC OIL FILTER *with* Monel Metal Insert

Reservoir Type for Hydraulic and Oil Re-circulating Machinery



EASY TO INSTALL—EASY TO CLEAN
LONG LIFE—LOW COST—SIZES AND SCREENS TO FIT YOUR NEEDS

★ ONLY THREE PARTS
★ MEETS J.I.C. STANDARDS
★ GREATER FILTERING AREA
★ SPECIAL TRAP-WEAVE MESH

Specially woven MONEL wire cloth and a new method of compact corrugation, gives triple protection with less space than other filters of like capacity. Trap-weave mesh stops thin, elongated particles with NO loss of efficiency.

Non-corrosive, non-toxic materials throughout. Easily cleaned with an ordinary brush.

Write for descriptive circular.

CAPITAL ENGINEERING & MFG. CORP.

5836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

Circle 23 on Reader Service Card

Circle 114 on Reader Service Card

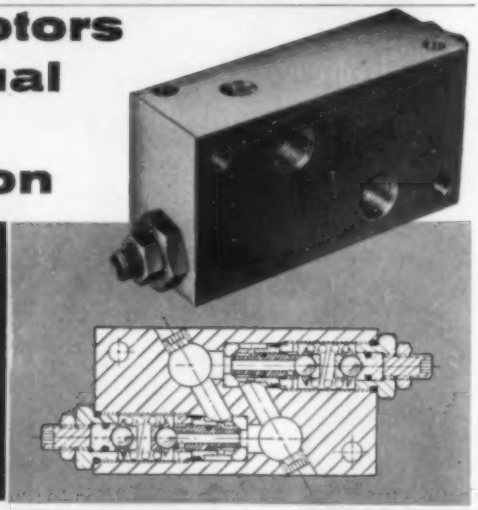
One leak or a thousand . . . if you have a similar frustrating experience in a metal-to-metal static sealing problem, United's Metallic O-Rings are the answer!

They fit any application calling for a positive, permanent seal against internal or vacuum pressures up to 10,000 p.s.i., in a temperature range from –70 to 1800°F. They are especially adaptable for sealing cylinder heads, air and hydraulic pressures, high octane fuels, vapors, gases, oils, solvents, chemicals, acids, vacuum and steam connections. Available in various metals and finishes, ⅜" to any size or configuration.

For free 22 page booklet describing United Metallic O-Rings, write (on your letterhead please) to Department ..-2.

UNITED METALLIC "O" RING CORP.
Dayton, Ohio • Box 1035
Division of United Aircraft Products, Inc.

Fluid Motors Need Dual Relief Protection



DUAL RELIEF VALVES

- Prevent excessive pressures at motor ports when valves are suddenly reversed or blocked.
- Assure smooth safe starting or deceleration of large loads.
- Available in Guided Piston or Differential Piston designs
- For Oil
- 600-1500-3000 P.S.I.
- ⅜", ½", & ¾" pipe sizes.

Write for detailed information and prices.

Fluid Controls, inc.
Member Of Fluid Power Association

Manufacturers of Hydraulic Valves and Devices
Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

1284 N. CENTER STREET • MENTOR, OHIO

Useful Literature / continued

MASTER-SLAVE UNIT . . . is described in a bulletin from Crown Controls Division of Trimount Instrument Co., Chicago. Their latest Hydra-Trol remote control has a positive stroke in both directions. It therefore offers immediate synchronization of the hydraulic control system in either direction. It is self contained and does not depend on either outside power or spring return.

Circle 160 on Reader Service Card

HYDRAULIC PUMPS . . . and motors, motorpumps, and hydraulic packages miniaturized especially for missile applications are described in bulletin A-5216, Vickers Inc., Detroit. Two series of constant-displacement piston type pumps are shown; several which deliver more than 5 hp per pound of weight. With a minor standard modification, these pumps also will function as hydraulic motors. As such they start, stop or reverse almost instantaneously to provide responsive, positive control. Also shown are several miniaturized packaged hydraulic power systems, and vane-type pumps.

Circle 161 on Reader Service Card

COATING . . . for interior or exterior application offers protection against the corrosive effects of hydraulic fluids, acids and chemicals. A product bulletin, available from Protex-A-Cote, Inc., Newark, gives a full description of Porselon. The coating is available in standard industrial colors. It can be applied to any clean surface using the same methods as applying paint.

Circle 162 on Reader Service Card

DATA CHART . . . which fully explains tolerances for steel tubing and pipe has been published by Peter A. Frasse & Co., New York City. Covered by the chart are tolerances for seamless and welded mechanical tubing, and seamless and welded stainless steel tubing and pipe. It explains each tolerance and gives the permissible variations in OD, ID, wall, ovality, and straightness.

Circle 163 on Reader Service Card

CONDENSED AIRCRAFT CATALOG . . . listing hose, fittings, elbow assemblies, and self-sealing couplings has been released by Aeroquip Corp., Jackson, Mich. Catalog 240 contains information on the company's standard aircraft products line and is designed for use in the aircraft maintenance field. Low, medium, and high pressure hose assemblies, charts, graphs and assembly instructions are included.

Circle 164 on Reader Service Card

COUPLER . . . for high and low-pressure fluid power systems is featured in a bulletin from E. B. Wiggins Oil Tool Co., Inc. Los Angeles. Connect-o-matic coupling test charts, dimensional drawings, photos, part number tables, and other types of couplings are included.

Circle 165 on Reader Service Card

COMPRESSOR BULLETIN . . . describes a new air compressor, the channel-flo. It is a two stage, 200 psig rated motor-compressor available in 1½ and 2 hp. The complete packaged unit includes the motor-compressor, cushioned rubber mounting on an ASME vertical tank, interconnecting piping and fittings and automatic start-and-stop control. Included are: photos, installation drawings, and specification charts. The bulletin is available from Ingersoll-Rand Co., New York.

Circle 166 on Reader Service Card

LINE STRAINER . . . features diverging entrance passage, balanced design, and self-cleaning action. Pictures and cutaway views are featured in a bulletin available from Ripley Mfg. Co., Croswell, Mich. Strainer sizes, filter element composition, and application ideas are also available.

Circle 167 on Reader Service Card

POWER UNITS . . . to control hydraulic equipment, scrapers, land levelers and farm implements are discussed in a 12 page catalog from Be-Ge Mfg. Co., Gilroy, Calif. Single and multi-valve units, and component parts are illustrated.

Circle 168 on Reader Service Card

WALL CHART . . . shows steel fittings for connecting steel tubing lines. Fittings are pictured and identified by part nomenclature. Included are standard triple-lok flare type, Ferulok flareless type and adapter fittings plus a tube fitting size table. Chart 4300C3 is available from Tube & Hose Fittings Div., Parker Appliance Co., Cleveland.

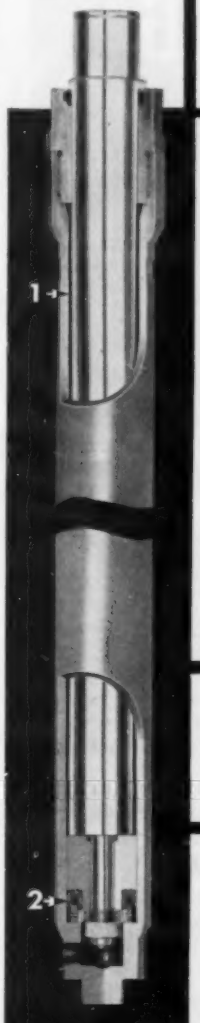
Circle 169 on Reader Service Card

AIR & OIL CYLINDERS . . . are described in 16 page catalog No. 100 issued by Logansport Machine Co., Inc., Logansport, Ind. The cylinders are equipped with hardened and chrome plated piston rods, and

Continued on next page

Good Design Deserves . . .

BHEW Custom-Built HYDRAULIC CYLINDERS



BHEW custom-built hydraulic cylinders give dependable operational performance wherever they are used. These efficient, close-tolerance cylinders require minimum mounting space; their cost is reasonable; there is no charge for tooling. BHEW builds cylinders to meet your specifications, delivers them on schedule.

BHEW CYLINDER FEATURES:

Standard and special designs available. • Double or single acting and telescopic. • 1½" to 8" bore. • Strokes up to 156". • Smallest possible O. D. and retracted O. A. length. • Oil cylinders with 1,500 psi or 3,000 psi working pressure, pneumatic up to 150 psi. • Cup-type, ring-type or O-ring construction. • Choice of mounting.

1. **Honed steel cylinder.**
2. **Full double-sealing "U" cup packing.**

Furnished in a wide variety of mountings and anchor brackets.

WRITE for your copy of Hydraulic Cylinder Engineering Reference Data Manual. Can save you hours of time in specifying cylinders. 40 dimensioned basic designs for general and special purpose double acting cylinders.

B H E W BENTON HARBOR ENGINEERING WORKS, INC.

622 LANGLEY AVENUE • ST. JOSEPH, MICHIGAN

Circle 21 on Reader Service Card

Useful Literature continued

are built in fourteen different mounting sizes from 1½ to 8-in. Operating pressures are 150 psi air or 300 psi oil. Included are: photos, dimensional drawings, specification tables, and local dealer listings.

Circle 170 on Reader Service Card

RELAY BOOKLET . . . published by Arrow-Hart & Hegeman Electric Co., Hartford, covers their line of type IMP (interchangeable-multiple-pole) and FMP (fixed-multiple-pole) heavy-duty relays. Diagrams, dimensional drawings, and photographs are used to illustrate the versatility of these relays. Parts are standardized and interchangeable throughout the entire line. Their adaptability for use with plug-in receptacle makes possible rapid examination or replacement of the basic relay without disturbing the wiring.

Circle 171 on Reader Service Card

PIPING AND TUBING . . . for elevated temperatures and pressures is featured in Bulletins 145 and 152 from Babcock & Wilcox Tubular Products Div., Beaver Falls, Pa. The folders present technical data on analysis, mechanical and physical properties, fabrication, heat treatment and maximum allowable pressures at different metal temperatures.

Circle 172 on Reader Service Card

SMALL CYLINDERS . . . are reviewed in a brochure from Munton Mfg. Co. Described are double-acting cylinders with 3/4 and 1-1/8 in. ID; 3/8, 1/2, and 5/8-in. hydraulic rams. Schematic sketches and price lists are also included.

Circle 173 on Reader Service Card

DISC FILTERS . . . of laminated fiber are included in a bulletin available from Wm. W. Nugent & Co., Inc., Skokie, Ill. The bulletin provides information on the design, construction, specifications and capacities of standard, high pressure and duplex models. Also included are special purpose assemblies, accessories and installation data.

Circle 174 on Reader Service Card

CYLINDER . . . which has many applications in tooling and automation is covered in bulletin 656 from Sheffer Corp., Cincinnati, Ohio. This cylinder is 1½-in. square and has a 1, 2, or 3-in. stroke. The bulletin contains a photo and dimensional drawings of the cylinder.

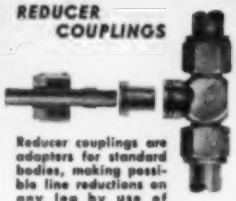
Circle 175 on Reader Service Card

VARIABLE-SPEED BELTS . . . are described in 8 page bulletin of Worthington Corp, Harrison, N. J. Four pages of tables cross reference Worthington-Goodyear belt numbers with other manufacturers' belt part numbers. Key to number coding for V-belt identification is also included.

Circle 176 on Reader Service Card

LENZ "O-RING"
NO METAL TO METAL SEAL
J.I.C. APPROVED
HELD BY FRICTION GRIP OF THESE TWO
NO CONCENTRATION OF STRESSES DUE TO FLARES OR FERRULES FOR TUBE FAILURE
NO EXACT TUBE LENGTH NECESSARY
NOT NECESSARY TO CUT TUBE SQUARE
SEAL AND GRIP ARE SEPARATE

REDUCER COUPLINGS



Reducer couplings are adapters for standard bodies, making possible line reductions on any leg by use of standard adapters and adapter nuts.

. . . A Hacksaw And A File Are All You Need

Excessive wrench torque is unnecessary for seal does not depend upon tightness of the nut. The higher the pressure the tighter the grip. Solve your hydraulic piping problems the easy way . . . with ease of assembly . . . no matching of exact tube lengths . . . simple leakproof connection for the life of the tube.

Reusable collet holds by friction grip up to bursting pressure of tubing.

LENZ FITTINGS MAKE THE JOB AS SIMPLE AS A B C

See our Catalog Page in Thomas Register 1956 Edition, Vol. 1, under classification "Fittings: Hydraulic" for complete list of types and sizes.

FOR MORE DETAILS, SEE PAGES 159-162 in the 56/57 Master Catalog of Fluid Power Products

LENZ COMPANY

BOX 1044-A • DAYTON 1, OHIO

PHONE: ORegon 9364 • 3303 KLEPINGER ROAD

DISTRIBUTORS IN PRINCIPAL CITIES

Circle 64 on Reader Service Card

HYDRAULIC SYSTEM COMPONENTS . . . are the subject of bulletin 810, Eastern Industries, Inc., Hamden, Conn. The 16-page illustrated listing contains product information and engineering data on hydraulic pumps, fluid motors, aircraft-type pumps, and servo systems. Small, high-speed gear pumps for aircraft and commercial use are also included.

Circle 177 on Reader Service Card

CATALOG REVISION . . . reviews the complete line of standard socket screw products, pressure plugs, and dowel pins manufactured by Standard Pressed Steel Co., Jenkintown, Pa. Product lines covered are heat-treated alloy-steel and stainless steel Unbrako socket-head cap and set screws from the micro-size set screw 1/16-in. long to the giant-size cap screw 3-in. in diameter and 12-in. long. Other products reviewed are stripper bolts, flat heads, button heads, square-head set screws, Dryseal-thread pressure plugs, precision-ground dowel pins and socket-screw keys. Size-by-size data on diameters, thread specs, lengths and packing and shipping information are included.

Circle 178 on Reader Service Card

PRESSURE GAGES . . . suitable for industrial, processing and chemical applications are graphically described and illustrated in 32 page catalog G-52, Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport, Conn. Engineering information describing how the gages work, types of systems, adjustments, applications, dimensional drawings, specifications, and accessories are given in addition to a listing of recommended uses.

Circle 179 on Reader Service Card

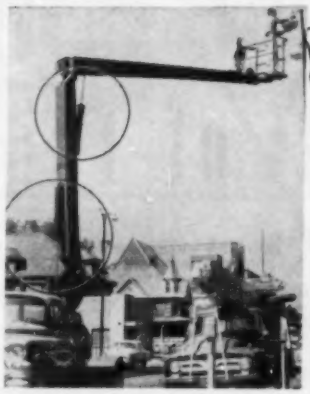
ELECTRONIC TIMERS . . . are described in a 4 page bulletin from G. C. Wilson & Co., Huntington, W. Va. Specifications, applications and operation of 11 timers of the repeat cycle, interval and delay types are discussed.

Circle 180 on Reader Service Card

POWER UNITS . . . of the electric-hydraulic and air-hydraulic types are described and illustrated in a color brochure available from Hi-Shear Rivet Tool Co., Torrance, Calif. Flow charts are included for both units.

Circle 181 on Reader Service Card

Circle 33 on Reader Service Card



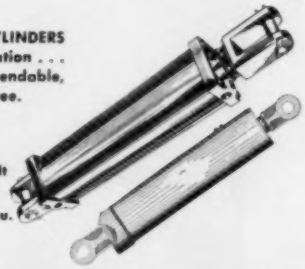
STRATO-TOWER Personnel Lift, powered by CROSS HYDRAULIC CYLINDERS.

"BEST HYDRAULIC CYLINDER AVAILABLE"

"We sincerely believe that there is no better cylinder," writes Mr. Shannon Clements of ELKHART WELDING & BOILER WORKS, INC. – STRATO TOWER DIVISION.

"Dependability is a must, when you're handling men and equipment high in the air! CROSS CYLINDERS have been leak proof beyond all expectations—giving trouble-free service, with a wide margin of safety."

Try CROSS CYLINDERS in your operation . . . low cost, dependable, and trouble free.



Fast delivery on any quantity, built to your specifications. Let our engineers help you.

HYDRAULIC CYLINDERS MFG. CO. CROSS

WRITE • WIRE • PHONE

CROSS MFG. CO.

LEWIS, KANSAS • Phone 86

FASTEST SERVICE...

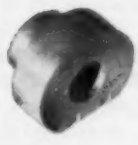
PROMET

ENGINEERED BRONZE BEARINGS
BUSHINGS
WEARING PARTS

Sound quality castings of any size, shape or section, rough cast or machine to precisely controlled tolerances. Difficult oil grooving... smooth even around acute bends.

Longer, Trouble-Free Service

OR YOUR MONEY BACK!



Write for free literature and service data sheets or send prints and conditions of operation for recommendations and quotations. No obligation.

THE American Crucible PRODUCTS CO.

1303 Oberlin Avenue — Lorain, Ohio, U.S.A.

Post Scripts of Industry

News about people, manufacturers and sales organizations

William A. Traut
Dynex, Inc.

Eugene C. Bleich
Precision Rubber Products Corp.

S. G. Paddock
Burgess-Manning Company

William A. Traut has been named staff engineering consultant for **Dynex, Inc.,** Milwaukee. With 32 years of engineering experience, Traut has held positions with many manufacturers, including Oilgear and Blackhawk. Prior to joining Dynex, he instructed aircraft hydraulics at Embry Riddle International School of Aviation.

Precision Rubber Products Corp., Dayton, announced the appointment of **Eugene C. Bleich,** sales engineer. He was formerly with Prepo Corp. and Gisholt Machine Co. His Florida branch office is at 711 Magnolia Ave., Orlando.

The name of Union Carbide and Carbon Corp., New York, has been shortened to **Union Carbide Corp.** The names of two divisions of Union Carbide have also been changed. Carbide and Carbon Chemicals Co. has become **Union Carbide Chemicals Co.;** and Linde Air Products Co. is changed to **Linde Co.**

S. G. Paddock was elevated to the office of executive vice president at the recent directors' meeting of **Burgess-Manning Co.,** Libertyville, Ill. He formerly served as vice president of the industrial silencer division. Also elected were **F. P. Hutchinson,** director; **E. D. Woisard,** treasurer and assistant secretary; and **A. W. Dreffein,** secretary.

Two vice presidents have been named for **A-P-D Co.,** recently organized affiliate of **Minnesota Rubber and Gasket Co.** They are: **Richard E. Tisch,** vice president in charge of product development; and **W. A. McGee,** vice president in charge of materials development. Both men have been associated with Minnesota Rubber and Gasket Co. A-P-D Co. began operations Jan. 1 as a centralized organization that would perform applied research for industry as well as for its parent company.

Charles Aust, has been promoted to the newly-created post of technical director of **Goshen Rubber Co.,** Inc., Goshen, Indiana. **Louis Rhodes** was made chief chemist, succeeding Aust.

H. Perry Smith has joined **Associated Spring Corporation,** Bristol, Conn., as assistant director of research. Smith will be at the research center in Bristol, where he will be directly in charge of the research and product development program.

Richard DeStefano has been named by **Minneapolis-Honeywell Regulator Co.** to direct nationwide sales of proximity switches. They are being marketed through the sales organization of the firm's Micro Switch Div., with headquarters in Freeport, Ill.

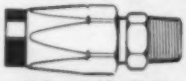
Continued on page 142

Circle 54 on Reader Service Card

LEAK-PROOF!

REQUIRE NO SPECIAL ASSEMBLY TOOLS

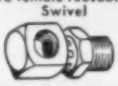
NEW HYDRALINK MALE SWIVEL REUSABLE COUPLING



Male reusable—Rigid

JIC male reusable

JIC female reusable—Swivel



90° Swivel elbow

Permanent coupling assemblies

Hydralink couplings, both permanent and reusable types, are quality units conforming design-wise with national and JIC standards but going a step farther in providing simplified installation and positive leak-proof seals that exceed the demands of peak pressure loads. The new Hydralink catalog is easy to read and helps you select the units you want without cross reference and guessing. Write for it today.

Several territories still available.

HYDRALINK CORPORATION

1009 E. 10 Mile Rd.
Hazel Park, Mich.

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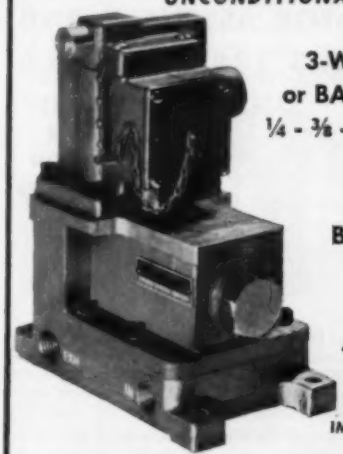
Solenoid Operated AIR VALVES

conform to all J.I.C. Standards

Stop Your Solenoid Troubles with AV VALVES Designed & Engineered for Many, Many Millions of Trouble Free Operations & Backed by 1 Year UNCONDITIONAL GUARANTEE



3-WAY IN-LINE or BASE MOUNTED

¼ - ⅜ - ½ - ¾ - 1 - 1¼

• • • •

4-WAY BASE MOUNTED

¼ - ⅜ - ½ - ¾

COMPLETE LINE OF AIR CONTROL VALVES

STOCKING REPRESENTATIVES IN IMPORTANT INDUSTRIAL CENTERS

Write for Bulletin and New Low Prices

AUTOMATIC VALVE CO.

37419 GRAND RIVER AVE., FARMINGTON, MICH.

Circle 20 on Reader Service Card

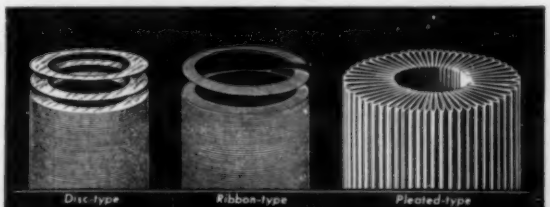
NOW AN ENTIRELY NEW *Bendix-Skinner* HYDRAULIC OIL FILTER

Approx. ½ size

OFFERING YOU FINER FILTRATION AT LOWER COST!

Here's everything you've wanted in a filter, including a built-in bypass—and all at a price equivalent to only six quarts of hydraulic oil! Yes, this newest addition to the Bendix-Skinner* line is truly the last word in efficient, yet economical, filtration. Its sturdy aluminum die cast construction assures long service—trouble-free, because it is available with either cleanable "ribbon" type elements for 40-micron filtration, replaceable "pleated" type for 10-micron filtration, or "disc" type, cleanable in 5 or ½ microns. Two ¼-inch N.P.T. inlets and two ¼-inch N.P.T. outlets make installation quick and easy. Operating pressure—100 p.s.i. Complete flow rate-pressure drop data on request.

*TRADE-MARK



Disc-type Ribbon-type Pleated-type

BENDIX-SKINNER DIVISION OF Bendix AVIATION CORPORATION

P. O. BOX 135, ROYAL OAK, MICHIGAN

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

ORIGINATOR OF **MICRONIC** FILTRATION

Circle 100 on Reader Service Card

Sonnet's NEW
Port Contour Cutter Produces
the NEW S.A.E.
Standard Hydraulic Boss
IN ONE PASS!

Cuts job time ⅔! This new special-purpose cutter has four flutes, with opposite flutes designed to perform the complete operation. A single pass of the cutter completes the chamfering, counterboring, radiusing, countersinking and spot facing operations necessary to produce the new S.A.E. straight tube hydraulic port boss. As a result, time required to complete the job is cut approximately ⅔!

Made from alloy-steel, the new tool is hardened for toughness and carbide tipped for long cutting life and smooth finish.

Write for sizes and prices today

Sonnet
TOOL AND MFG. CO.
576 No. Prairie Avenue, Hawthorne, California
Precision cutting tools in high speed steel and carbide

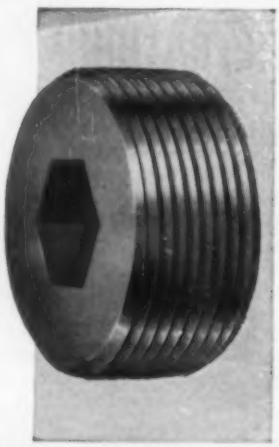
Post Scripts of Industry
continued

Martin Elander, secretary and treasurer of **United Aircraft Products, Inc.,** Dayton, was given the additional title of vice president in charge of finance.

Promotion of **Tom Welsh** to eastern sales manager, a new post, was announced by **Snap-Tite, Inc.,** Union City, Pa. He was previously assistant sales manager.

Modernair Corp. has expanded production, engineering and administrative office facilities at San Leandro, Calif. Engineering, sales, plant supervision, purchasing and administrative offices are now housed in the modern two-story structure. Visitors to the new plant are greeted by a display of the company's fluid power products, presented in action in the reception lobby. An explanation of the display is silently transmitted by induction to tiny wireless earphones worn by the viewer.

specify
standard
UNBRAKO
Dryseal-thread
Pressure Plugs
for hydraulic
or fuel systems

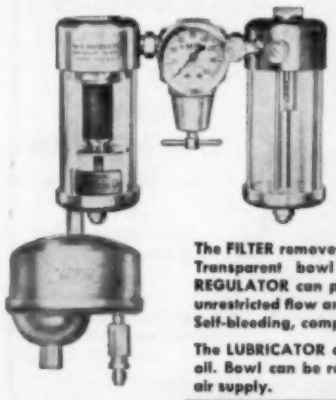


Use them wherever liquids or gases must be contained under pressure—or in place of ordinary pipe plugs. UNBRAKOs seal without compound. They are made of the same high-strength alloy steel, have the same internal wrenching feature as UNBRAKO socket screws. Fully formed threads exceed NPTF specifications. Standard sizes—⅛ to 1¼ in.—are stocked by your authorized industrial distributor. See him for details. Or write Unbrako Socket Screw Division, STANDARD PRESSED STEEL CO., Jenkintown 2, Pa.

UNBRAKO SOCKET SCREW DIVISION
STANDARD PRESSED STEEL CO.
SPS
JENKINTOWN PENNSYLVANIA

GREATER PROTECTION
to your AIR LINE!
M·B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)



SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039-and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

M·B PRODUCTS
46 VICTOR AVE., Div. 10
DETROIT 3, MICHIGAN

Circle 102 on Reader Service Card

Circle 68 on Reader Service Card

Precision Rubber Products Corp., Dayton, announced the appointment of **Clem W. Weston** as a jobber to serve the states of Louisiana, Arkansas and Mississippi. He will operate from offices at 1124 Burgundy St., New Orleans, and 494 Ockley Drive, Shreveport.

Gerotor May Corp., Owings Mills, Md. announced the appointment of **Gordon L. Knudson** as district representative covering the midwestern territory. He will headquarter in Chicago.

E. F. Houghton & Co., Philadelphia, is expanding its manufacturing facilities in Detroit. The new factory, office and laboratory space will adjoin the present Lumpkin Ave. location.

Discussing a model of the new plant are **Dr. James T. Eaton,** vice president, production; and **William F. MacDonald,** president of Houghton.

Morgan C. Plummer has been appointed to the newly-created position of supervisor of Pydraul sales for **Monsanto Chemical Co.,** Organic Chemicals Div.

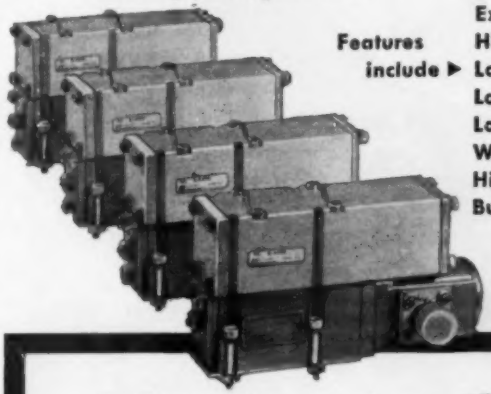
R. L. Leslie, supervisor of hydraulic fluids research, **Vickers Inc.,** Detroit, has been appointed chairman of the Hydraulics and Hydraulic Machinery Committee of the American Society of Lubrication Engineers.

Continued on next page

Now in mass production . . .

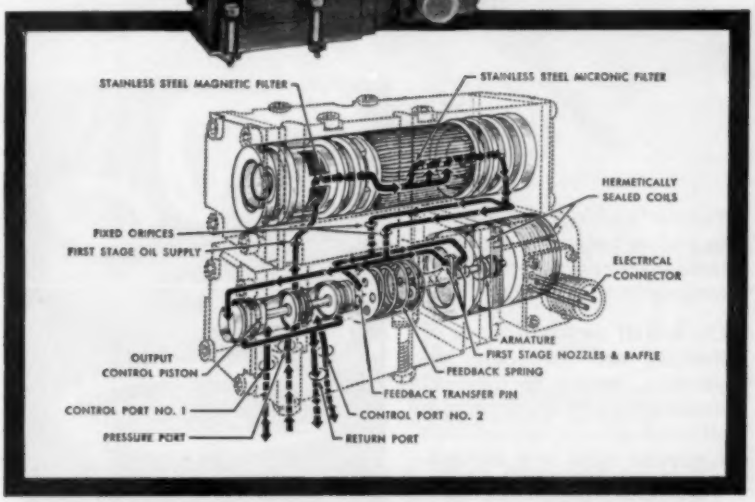
SANDERS SA-19 SERVO VALVE

The Sanders SA-19 Servo Valve provides unparalleled efficiency and reliability for a wide variety of electro-hydraulic components and systems. Utilizing the Sanders internal force feedback principle, this two-stage electro-hydraulic amplifier develops large hydraulic output flows with relatively low input electrical power requirements.



Features include ▶

- **Excellent Resolution**
- **High Power Amplification**
- **Low Hysteresis**
- **Low Threshold**
- **Low Input Power**
- **Wide Frequency Response**
- **High Stiffness of Control**
- **Built-in Filtration**



Operation: An input current, converted to a magnetic force in the First Stage Armature, moves the First Stage Baffle between two nozzles causing a pressure differential across the ends of the Output Control Piston. The resulting motion of the Output Control Piston is fed back through the Transfer Pin and Feedback Spring as a restoring force on the First Stage Armature, thus nulling the valve and porting oil to the load. The First Stage Oil Supply is thoroughly filtered as shown.

Typical Specifications The following are typical specifications for this valve. Higher pressure and higher frequency versions are also available.

Force Motor • Coil Resistance (ohms/coil) 400 • Differential Current ± 20 ma • Input Power 0.16 watts

Hydraulic Valve • Flow (GPM @ 1000 psi across valve) 10 • System Pressure (psi) 400 • Resolution (% of Full Signal) ± 0.125 • Hysteresis (% of Full Signal) ± 2.5

Write today for complete information.

SANDERS ASSOCIATES INCORPORATED
Dept. B NASHUA 8, NEW HAMPSHIRE

West Coast Field Office: 7335 VAN NUYS BLVD., VAN NUYS, CALIFORNIA, Tel. STATE 0-2720

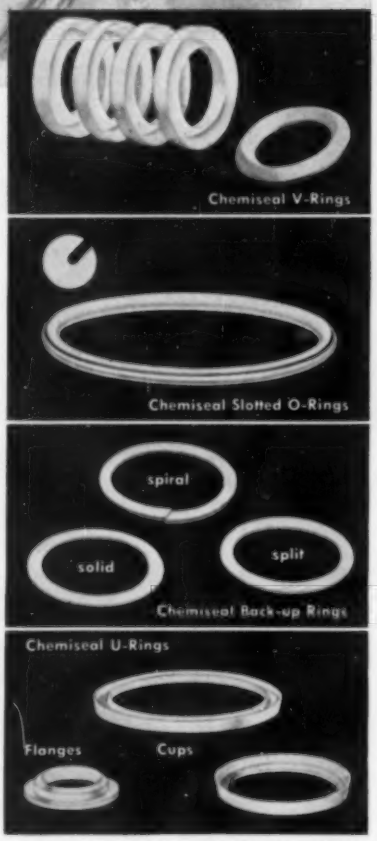
TEFLON* packings are preferred by leading hydraulics engineers because they provide maximum security at vital points.

Chemiseal† packings, made of TEFLON, are chemically impervious, require no chemical inspection, have zero swelling in all hydro-carbons, new synthetic hydraulic fluids and solvents.

They offer unsurpassed anti-friction properties, are tough, resilient, non-flammable, long wearing. They have a service temperature range from minus 110° F to plus 500° F.

Have you tested the complete line of Chemiseal packings for aircraft hydraulics? Write for further information and samples.

United States Gasket Company
Camden 1, New Jersey



†U.S.G. trademark

*du Pont trademark for its tetrafluoroethylene resin.

United States Gasket *Plastics Division*
OF THE GARLOCK PACKING COMPANY

Post Scripts of Industry
continued

F. V. Gieryn was named sales manager, industrial dept., Machinery Hydraulics Div., **Vickers Inc.** Gieryn was formerly manager of export sales.

F. V. Gieryn
Vickers Inc.

Knox, Inc., East Walpole, Mass. announced the election of **Robert Benton** as vice president. He will continue his duties as manager of the company's Springfield office. They have also appointed **Dan Knight** to their sales staff. He covers northeastern Mass., southeastern N. H., and southern Maine.

Robert Benton
Knox, Inc.

Lyman A. Bullard Jr. was named sales manager of **Eastern Aircraft Products Corp.,** Orange, N. J., a subsidiary of Weatherhead Co. The appointment of **Nelson Kling** as chief design engineer, and **Bernard Wasdyke** and **Marvin Rosenfeld** as project engineers was also announced by the company. Kling was formerly chief engineer with Arkwin Industries.

Auto-Diesel Piston Ring Co., Cleveland, has appointed **Clifford-Rockwell Co.,** Detroit, their sales representative. Their territory includes Michigan, northwestern Ohio, and northeastern Indiana.

Flexonics Corp., Maywood, Ill. has announced the formation of a western regional office, headquarters for sales, service and field engineering west of the Rockies. **George W. Derum** is the manager. The office is at 10711 Chandler Blvd., North Hollywood, Calif.

Don S. Permar has been named to the newly created position of assistant general sales manager for the **LeRoi Div., Westinghouse Air Brake Co.,** Milwaukee. Permar has been field sales manager for Le Roi since 1954. He will continue to be directly responsible for the operation of the field sales staff.

Continued on page 147

how the world's largest vacuum furnace safeguards against fire in case of hydraulic line rupture

See page 17, this issue, for an actual history of Vacuum Metals Corp.

(Advertisement)

Circle 92 on Reader Service Card

CUT MAINTENANCE COSTS! SAVE DOWN TIME! on your Hydraulic System

Keep it clean *with*

SCHROEDER LINE FILTERS

The Schroeder Line Filter is the answer to keeping harmful dirt from slowing down the operation of your hydraulic equipment. This small, all-in-one unit has a large filtering capacity and removes damaging particles too small to be seen.

Here's why SCHROEDER LINE FILTERS are preferred:

- Filter element costs little and is replaceable.
- Fliptop cap permits minute change of element.
- Designed for space-saving installation.
- Many types and makes of filter elements available.
- Minimum cost for maximum filtration area.
- Element protected by built-in by-pass relief.
- Built-in orifice for partial filtration available.
- Working pressures conservatively rated—each unit shop-tested.

Optional Spin-Dicator provides visual supervision of performance.

SCHROEDER BROTHERS CORPORATION
NICHOL AVE., BOX 72, McKEES ROCKS, PA.
(Pittsburgh District)
Hydraulic, Electric and Pneumatic Equipment

REDUCE WEAR AND DOWN TIME... Install SCHROEDER LINE FILTERS

WesCo has hundreds of Aircraft and Industrial solenoids

Look to **WesCo** engineers with your aircraft or industrial solenoid problem. Hundreds of proven designs available. **WesCo** will modify or furnish special designs to fit your specifications.

Here are some of the features available:
High temp units tested past 600°F. • Adjustable plunger travel • Plunger cavity pressure sealed • Push or pull types 12 to 115 volts • Miniature, medium and heavy duty types • 400 cycle AC units also available.

Remember, when you need a solenoid, think of **WesCo AC INDUSTRIAL SOLENOIDS**—full line. Write for brochure. **DC AIRCRAFT SOLENOIDS**—send specifications, or write for catalog.

The trademark on millions of solenoids since 1927

WesCo

WEST COAST ELECTRICAL MFG. CORP.
233 WEST 116TH PLACE • DIVISION 119
LOS ANGELES 61, CALIF. • PLymouth 5-1138

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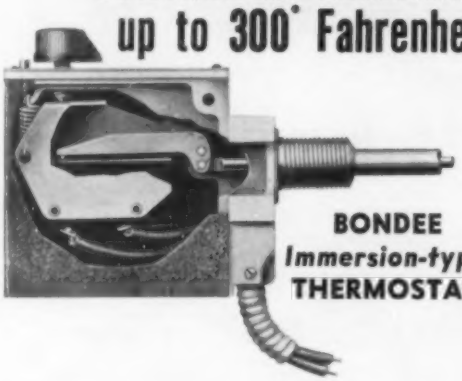
Circle 5 on Reader Service Card

WHERE CLOSE TEMPERATURE CONTROL IS ESSENTIAL up to 300° Fahrenheit



BONDEE
Immersion-type
THERMOSTAT

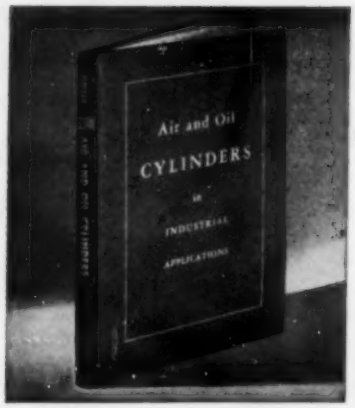
ECONOMICAL—EASILY INSTALLED

Rod and tube thermal element ruggedly constructed. Snap action contacts. For 15 Amps, 125 Volts, A.C.

Immediate Delivery

ALLOY BELLOWS, INC.

18124 Roseland Rd., Cleveland 12, Ohio



AIR & OIL CYLINDERS

Elmer Heiser has written this valuable cylinder handbook which tells about types, cushions, how to order, proper porting, correct sizing, packings, and efficient installation methods.

It's full of application ideas.

PRICE $5.00

The Industrial Publishing Corporation

812 Huron Road • Cleveland 15, Ohio

TEFLON HOSE SWIVELS

Mayson Hose Swivels with stainless bodies and Teflon packings are handling a long list of chemicals and gases without lubrication.

Mayson's exclusive controlled pressure drop mounting of packings permits much higher pressure-velocity ratings.

½" and ¾" pipe size Teflon swivels are now in production.

MAYSON MFG. CO.

4332 HORATIO STREET • DETROIT 10, MICH.

for highly corrosive fluids at pressures to 3000 psi

specify

Atkomatic STAINLESS STEEL solenoid valves

features include:

- Packless, globe type, two-way, pilot-piston operation
- Full ported design—½", ¾", 1", 1½" sizes.
- 316 stainless steel construction for maximum corrosion resistance.
- Resilient valve seats for bubble-tight, leak-proof seal.
- Instantaneous or delayed closing speed as desired.
- Single-wound "high pull" coil for pressures to 1500 psi; pressures to 3000 psi require double wound coil and relay.

Highly corrosive liquids and gases plus air, water and oil can be controlled safely and surely even at 3000 psi with Atkomatic Stainless Steel Solenoid Valves.

Solve your flow control problems Atkomatic-ly! Send for free 20-page Catalog No. 200-A.

Atkomatic VALVE CO., INC.

Dept. 4-A, 545 W. Abbott St., Indianapolis, Indiana

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Circle 11 on Reader Service Card

MARKET PLACE

When replying to a box number in the Market Place, address your letter to Applied Hydraulics, 812 Huron Road, Cleveland 15, Ohio. Attention: Box No.

WANTED
MANUFACTURERS' REPRESENTATIVES

To handle complete line of Component Hydraulic Filters for pressures of 5000 psi and flows from 15-90 gpm. Filters have special designed head—no bolts, removable in 10 seconds. Specification sheets available.
These filters are the beginning of a line of hydraulic components to supplement our test equipment business. We are one of the country's leading Test Equipment Manufacturers. All territories open. Qualified Representatives already established only need apply. Prefer experience and contacts in the aviation and hydraulic fields and carrying a pump line. Submit complete data on your operation including history, territory, lines now carried, financial status, personnel, etc. to:

Consolidated Diesel Electric Corp.
Test Equipment Division
1 John Street
Stamford, Connecticut
Attention: Mr. L. B. Haberman,
General Manager

AN HARDWARE & FITTINGS

Stainless, Aluminum, Brass, Steel. All sizes—immediate delivery from world's largest shelf stock. Buy direct from manufacturer. Lower prices—quicker service. Send for free wall charts showing complete line of AN Fittings.
COLLINS ENGINEERING CORPORATION
9050 Washington Blvd.,
Culver City, California

Sales Engineer

For Sales and Engineering work in Hydraulic and Pneumatic Leather and Rubber packing installations. Some technical and engineering aptitude desirable coupled with good sales sense. Relocation may be necessary after a year of training. Promising future with solid company. Let us have your background and salary area. Write Box 8157, APPLIED HYDRAULICS.

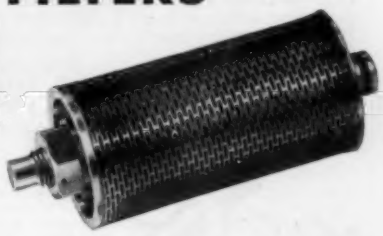
Distributors Wanted

Distributors wanted for patented Metallic Rod Wipers. The Seal Guard is standard equipment on several makes of pneumatic and hydraulic cylinders. We have a national distribution program in progress with several exclusive territories open. Submit resume of lines carried, territory covered and experience in the hydraulic and pneumatic field. See our ad on page 122 of this issue.
Mail replies to: HYDRAULIC ACCESSORIES COMPANY, 24301 Hoover Road, Van Dyke, (Detroit), Michigan. Attention Mr. T. W. King Sales Manager.

Advanced Filtration

CUNO **PORO-KLEAN**
MAGNETIC
FILTERS

LINE TYPE
MAGNETIC FILTER HOUSING
AND TYPICAL CARTRIDGE



- **FINE FILTRATION** 5 microns
- **HIGH TENSILE STRENGTH** 15,000 p.s.i.
- **HIGH HEAT RESISTANCE** 900° F.
- **NO PARTICLE DISCHARGE**
- **STAINLESS STEEL CONSTRUCTION**
- **MAGNETIC CONSTRUCTION** 1 micron retention

All the advanced filtration characteristics to meet the specifications you are looking for, with *Micronic-Mechanical* Filtration as fine as 5 microns and *Micronic-Magnetic* Filtration removing *sub-micronic* ferrous particles.

Available in either Line or In-Line type filters with various flow rates to meet your specifications.

WRITE NOW FOR FULLY DESCRIPTIVE LITERATURE . . . *Free Poro-Klean Bulletins will be sent to you by return mail.*

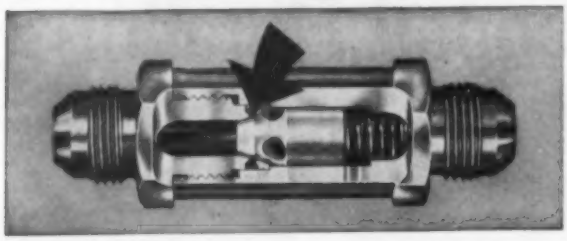
A COMPLETE APPLICATION ENGINEERING SERVICE
The Cuno Field Engineer in your area can help you select the right filter to solve your hydraulic filtration problems.

CUNO ENGINEERING CORPORATION
208 SOUTH VINE STREET, MERIDEN, CONN.
TELEPHONE: BEverly 7-5541
EDGE-TYPE, WIRE-WOUND, SCREEN, FIBER CARTRIDGE and POROUS METAL FILTERS
Filtration Engineers *In Principal Cities*

Circle 60 on Reader Service Card

Simple, Secure . . . Leak-Tight!

The FLEXIBLE SEAL SEAT*



Responsive action of the soft O-ring seal provides absolute leak-tightness. Instantly compresses to seal internal and external pressures. Draws harmlessly around dirt particles. No costly precision parts; no extra end seals. Stocked in 6 standard Dryseal pipe and JIC tube sizes; 12 connection combinations. Write for data sheet.

KEPNER PRODUCTS COMPANY
7321 West 59th Street • Summit, Illinois

Kep-O-seal

HYDRAULIC & PNEUMATIC
CHECK VALVES

* PATENT APPLIED FOR

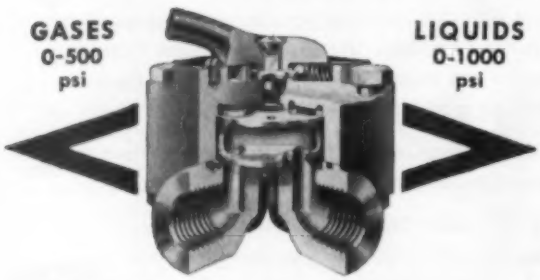
New

REPUBLIC

SEAL-TITE VALVES
PRESSURE BALANCED

GASES 0-500 psi

LIQUIDS 0-1000 psi



- ⅛" to 1" FPT −65° to 160°F
- 2, 3, 4-way
- Turning ease
- Zero leakage
- Increasing pressure tightens seals.
- Positive flow control

Ask for Catalog No. 356

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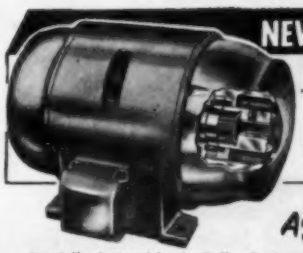

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3/4 to 15 HORSEPOWER

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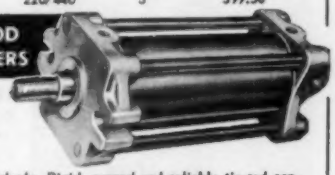

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300-36	3"	36"	1060 lbs.	5300 lbs.	59.05
400-12	4"	12"	1885 lbs.	9425 lbs.	49.50
500-4	5"	4"	2950 lbs.	14,725 lbs.	69.90
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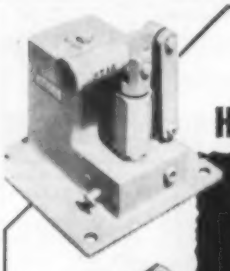

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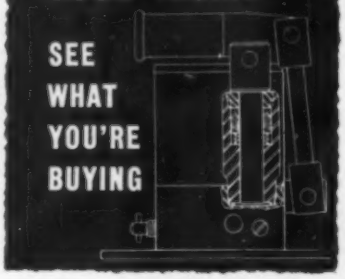

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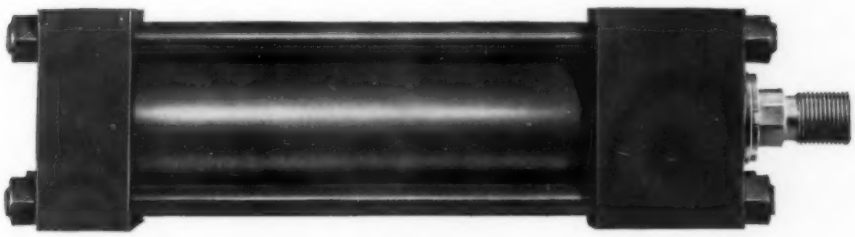

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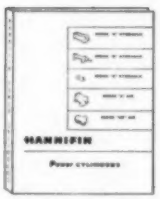

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